

Semi-Final Draft of
Report on the
WATER SUPPLY AND SANITATION PROBLEM
in
THE PHILADELPHIA TRI-STATE DISTRICT

Supplement to Chapter X of the Regional Plan Report
approved by the
Committee on Water Supply and Sanitation, June 30, 1931

Prepared for
Submission to the
WATER SUPPLY AND SANITATION COMMITTEE
August 1931

The Regional Planning Federation
of
The Philadelphia Tri-State District
1700 Fox Building
Philadelphia

REGIONAL PLANNING FEDERATION
OF THE
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1700 FOX BUILDING, PHILADELPHIA

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Maps and Tables

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P R E F A C E

The material presented in the following pages is supplemental in character to the main chapter of this report devoted to the Water Supply and Sanitation Problem. It contains the supporting data for the statements made and the conclusions reached, in greater detail than in the fore part of the report. There is, of necessity, some repetition of the expositional matter to carry the thought and reasoning along consecutive lines.

The subject matter has been divided for convenience in presentation into three parts as follows:

- I. Water Supply
- II. Sanitation
- III. The Combined Problems

It is recognized that the subjects of Water Supply and Sanitation are closely interlocked and that it is difficult to portray the portent of one problem without showing its relation to the other. There is, therefore, some overlap necessary in such divided presentation, making desirable a short summary in Part III. of the combined problems together with reference material bearing on its solution.

Two maps are exhibited, one showing with respect to Water Supply, conditions of outstanding importance in or to the region, and the other the Sanitation situation and its relation to the water supply problem. The Water Supply Map covers the entire Delaware watershed and adjacent territory in New York State. It has been subdivided to show the principal subsidiary watersheds now used or proposed to be used for water supply in the region or affecting the supplies for the region. Within the Tri-State District are outlined the areas now served by publicly and privately owned water supply systems, the sources of each supply and the relative quantities drawn from each. The

Sewerage Map covers only the region and gives the principal drainage areas into which it is divided, the communities sewered, and those in which the sewage is treated as well as the relation to sources of surface water supply.

Tables I to IX appended to the report give a complete summary of all statistical data relevant to a regional study of the Water and Sanitation problem. They give the general facts about every political subdivision in the area. Special reference is made to Table I, which indexes each of the 400 divisions into which the region is divided.

All facts included in this report have been obtained after a careful field survey extending over a three year period and made possible thru the cooperation of State and local authorities and a study of the available public records. Acknowledgement is made of the generous assistance of responsible officials in the following agencies: The Departments of Health in Pennsylvania and New Jersey and the Board of Health in Delaware; the Public Service Commission in Pennsylvania and the Board of Public Utility Commissioners in New Jersey; the Pennsylvania Department of Forests and Waters; the New Jersey Department of Conservation and Development, and the State Water Policy Commission; and officials of individual municipalities. Acknowledgement is also made of valuable help from the practicing consulting engineers in the region whose records and local knowledge have been made available when requested. The Board of Water Supply of New York City and the United States Army Engineers have also cooperated extensively. State and municipal reports of many past years have been exceedingly valuable as reference material in this study.

In spite of this assistance, complete information has not always been obtainable, nor has it been possible to reduce it all to a comparable basis. In the nine tables appended hereto which are listed in the Table of Contents, notation is made in usually minor instances, wherein it has been necessary to give an estimated figure. Nevertheless, it is to be noted that all figures used in this report are to be considered as approximate only,

though representing as reliable data as can be obtained. Great care has been exercised in using only the best and so far as possible original sources of information.

With reference to present population, unless otherwise stated, all statistics are taken from the results of the 1930 U.S. Census of Population and hence represent conditions as of April 1, 1930:

It is thought that the facts, especially in regard to consumption of water, should be exceedingly valuable for comparison at some future time as well as for their significance today. The tabular data represents only the essential and most important information. There is considerable other material of more detailed nature on record in the files of the Federation available of course to technicians and others for any useful public purpose.

THE WATER SUPPLY AND SANITATION PROBLEM

Supplement to Chapter X.

SECTION I.

WATER SUPPLY

GENERAL STATEMENT

Regional Aspects

The more intense and complex a civilization becomes, the more dependent it is on communal functions, of which water supply is now well established as an indispensable necessity. In a great urban industrial region such as the Philadelphia Tri-State District, the extent of territory, the numbers of its people, the diversification and independence of its political divisions, and the needs of its industries, combine to show an ever growing dependence on the water resources with which the area is endowed.

Noted engineers, and other outstanding men in public life, have said that the growth of the modern city will be limited eventually by the feasibility with which its people may be provided with an adequate, safe and economic supply of water. But the large city is only the nucleus of an extensively inhabited area about it. It is now evident that provisions for the further growth of city and surrounding region must be closely correlated, and in perhaps no other respect is this more important than in the utilization of water resources.

The modern tendency in many metropolitan centers, is for the cities and other densely inhabited areas to reach out and tap new and better sources of water supply to supplement or replace those nearby which earlier were quite adequate as to quantity and suitable as to quality. The need for such

changes has been brought about by circumstances of far reaching extent. Furthermore, the process of change entails additional considerations of even greater magnitude and influence, calling for even more coordination than is needed for present exigencies.

This report has been limited to the presentation of four aspects of regional significance. These are: the sources of supply, their location, quantity and quality; the water requirements of the region and its parts, now and in the future; the methods of distribution, and the opportunities and need for a program designed to conserve and utilize fully the available water resources.

Sources of Supply

The importance of the existing and potential sources of water supply to the people of the region is most apparent when they are compared with each other and with the communities which use them. This inter-relation of communities and inter-dependence on source has many ramifications, the most obvious being concerned with the quality of water, should it be polluted to any marked degree by other communities or industries situated upstream. Again, the supply of one community or section is often taken from sources locally used by other communities, which as they expand, find their needs from the same source in conflict with those of the first community. As the developable limits of each source are approached, difficult legal questions arise as to the priority of right to the water, and should this water be diverted permanently from the watershed and not be returned to the same stream within a reasonable distance downstream for the use of other communities, the situation has extensive significance. It is apparent that we have entered already in some outstanding instances, a competitive era of struggle for water; of which the most important aspect is inter-regional, and hence interstate, in extent.

Water Requirements

Another regional factor which must be considered is the total present and future water requirements of the region as a whole and the proportion needed in the different sections of the region. Due to markedly different rates of population growth in these sections, and wide variation in the per capita use of water, the water supply needs in each area are increasing at quite different rates. Any plans that may be evolved to meet future requirements must naturally take into account such variations.

Means of Distribution

Of regional significance, though perhaps not as important as the questions of source and consumption of water, is the method of distribution of this supply throughout the region. There is already a tendency toward the combination of facilities in the distribution of water, brought about the economic necessity for pooling resources, abandonment of small local supplies and the consolidation of private systems. Instances of this have already taken place in the Tri-State District where many communities have so grown together as to constitute one continuous suburban area.

Conservation and Development of Water Resources

Finally, there are generally accepted principles of conservation which are applicable to any development of these water resources and which have a definite bearing on the proposals of the Regional Plan for open space reservations. The proper protection and utilization of the principal creek valleys in the region for recreational purposes, commendable on its own merits anyway, is further justified when considered in relation to the development of the stream for water supply purposes. The possibilities for coordinate use of water supply properties as an adjunct to the regional park and parkway system have been worked out successfully elsewhere, though in the Tri-State District there is no outstanding example of such coordination, except, perhaps, Fairmount Park.

Maps and Tables

Conditions of outstanding importance in, or to, the Tri-State District are depicted upon a single map and shown opposite page _____ of the general report, covering the entire Delaware watershed. Reference is made to the preface of this section, wherein are described the sources of information. Statistical data is summarized in Table I to VII.

EXISTING CONDITIONS IN THE REGION

Water Resources

The record maps and data given in the tables show that the present sources of supply for the Tri-State Region are all taken from points located physically within the Region though, of course, when directly from the Delaware and Schuylkill Rivers, much of the natural source lies outside. Almost the entire populated area drains to the Delaware River, for included within its watershed is 98 per cent of the total population and 87 per cent of the area of the Region.

The table shown below gives a complete summary of the division of the area of the Delaware drainage basin by States, above, within, and below the Tri-State Region. The Delaware Bay comprises 513 square miles or 28.9 per cent of the area below the region.

The Delaware Watershed* (To Capes May and Henlopen)

<u>States Lying Partly Within Delaware Watershed</u>	<u>Drainage Area in Square Miles</u> (Land and Water)			
	<u>Outside Region (Above)</u>	<u>Tri-State Region</u>	<u>Outside Region (below)</u>	<u>Total</u>
New York	2,362	-	-	2,362
Pennsylvania	4,330	2,092	-	6,422
New Jersey	991	1,429	569	2,989
Delaware	-	432	684	1,116
Maryland			8	8
Unclaimed			513	513
Total -	7,683	3,953	1,774	13,410
Per Cent	57.3%	29.5%	13.2%	100.00%

*(Areas compiled from data from U.S. Engrs. office and U.S. Census Bureau.)

It is seen that the Tri-State Region embraces 29.5 % or a very considerable portion of the Delaware watershed and furthermore that it is situated strategically on the lower portion of this great basin, among the largest draining the Atlantic Seaboard of the United States. The average annual yield of this river for the 11,596 square miles above Woodland Beach, Delaware, near the southern boundary of the region is estimated to be about 1.65 cubic feet per second per square mile of drainage area or about 12,400 million gallons per day.

Only 16.2 % of the region lies outside the watershed of the Delaware, with 12.1% in New Jersey, 2.8% in Pennsylvania and 1.3 % in Delaware, as follows:

Watersheds of the Tri-State Region*

<u>Principal Watersheds</u>	<u>Drainage Area in Square Miles</u> (Land and Water)			
	<u>Pa. Part</u>	<u>N. J. Part</u>	<u>Del. Part</u>	<u>Total</u>
Delaware Watershed	2,092	1,429	432	3,953
Susquehanna Watershed	130	-	63	193
Raritan Watershed	-	92	-	92
Wading, Mullica, and Egg Harbor Watersheds	-	477	-	477
Total	2,222	1,998	495	4,715

*(Areas from U.S. Engrs. office and U.S. Census Bureau)

The table on page _____ gives a list of the principal tributaries within the region their drainage areas and the proportion within each part of the region. An examination of this table shows that the most important tributaries lying largely within the region are in order of area drained, the Schuylkill, the Brandywine, the Rancocas, and the Neshaminy. The Perkiomen is one of the largest but is tributary to the Schuylkill. All of these, except the Rancocas, are important existing or proposed sources of water supply.

Distribution of Population

Of basic importance in analyzing the water supply problem in the region is knowledge as to the distribution of the population that is served by development of the foregoing water resources. Water, as a commodity, a source of power, and as a channel for commerce and communication has had an important part in determining where people live and work.

The early settlements of the Region were founded along the banks of the Delaware and its main tributary, the Schuylkill River. From them have sprung the larger cities which, with their adjacent suburban communities, concentrate the bulk of population along these two waterways.

The 1930 Census showed that the urban population in the region constitutes 2,928,146 or 83% of the total of 3,522,049. For the most part, these urban areas embracing only 7.3% of the entire regional area, are situated within 5 miles either side of the Delaware and Schuylkill Rivers, with only 137,323, of the urban dwellers, or 4.7% in scattered communities outside this area. The urban centers alone, within this ten mile belt, have an average density of 10,350 persons per square mile, whereas the entire hinterland, urban and rural, and including the rural areas within the belt has a density of only 170 per square mile. The significance of this low density of population over such a large proportion of the Region lies in the fact that the natural drainage from the rural section is thus usually toward the urban territory situated along the river banks. Potentially, therefore, there lies back of the bulk of the populated centers, a relatively thinly populated watershed which may be susceptible to the development of a comparatively pure, and perchance, gravity supply of water. Many important communities besides Philadelphia, however, still draw their water supply from the main stream of the Delaware and Schuylkill Rivers.

Surface Water Supplies

The importance of surface water resources in meeting the water supply needs of the Region, is shown by the fact that out of a total of 467 million gallons per day, publicly supplied in 1927, 430 million gallons, or 92 per cent, came from surface supplies; and only 37 million, or 8 per cent, from underground sources. A study of the data in Table 2 shows that 87 per cent of the total population supplied in the Region obtains its water from surface supplies.

The total of 430 million gallons per day from surface supplies in 1927 was obtained as follows:

215 million gallons, or 50%, from Delaware River proper
180 million gallons, or 42%, from Schuylkill River proper
35 million gallons, or 8%, from tributaries of each river.

Further subdividing the supplies, information taken from Table 3 indicates the following relative volumes of water taken by Pennsylvania, New Jersey and Delaware, from the Delaware and Schuylkill Rivers, and from their tributaries:

For Pennsylvania:

197 million gallons, or 46%, from Delaware River proper.
180 million gallons, or 42%, from Schuylkill River proper.
20 million gallons, or 5%, from tributaries of each river.
397 million gallons, or 93%, of total surface supply.

For New Jersey:

18 million gallons, or 4%, from Delaware River proper.
Less than 1 million gallons or less than 0.1% from tributaries.
18 million gallons, or 4%, of total surface supply.

For Delaware:

15 million gallons, or 3%, from tributaries, equivalent to 3% of total surface supply.

With Philadelphia drawing a daily average of 189 million gallons from the Delaware and 171 million from the Schuylkill or a total of 360, it is apparent that the city consumes about 77% of all water used or 84% of

that from surface sources. However if the city's draught is excluded from the amounts shown above, then it is evident that there are still 26 million gallons drawn from the Delaware and 9 from the Schuylkill by other communities. Compared with the 35 million taken from tributaries throughout the region, then, these rivers are equally as important as sources of water supply to population centers outside of Philadelphia, as are the tributaries. Tributaries supply 434,000 persons whereas the two main rivers supply 340,000 outside of Philadelphia.

Development of Surface Supplies

The statement has been made that the Delaware River still flows "unvexed to the sea" though all the other large rivers of the North Atlantic Seaboard have been extensively developed, regulated and utilized. This is largely true for the river above Trenton, but below that point important utilization is made of the river for water supply purposes; although, from an engineering point of view the river has not been developed to any degree.

The minimum low water flow (monthly average) of the Delaware at Trenton Falls, as shown over a period of years in Table 7, is approximately 1,000,000,000 gallons per day. There are drawn from the river progressively from Trenton down stream the following volumes of water:

At Trenton and Morrisville,	17 million gallons daily
At Bristol and Burlington,	3 million gallons daily
At Philadelphia,	189 million gallons daily
At Chester,	<u>6</u> million gallons daily
	215 million gallons daily

In each instance, the water taken from the river is returned as sewage within distances up to 20 miles below the point of intake, and also in each instance above the point at which the next draft is made. Thus, while the total draft on the river is about 1/5 of its minimum flow, the

diversion at no point is more than 1/6 of the available undeveloped low water yield of the river.

On the Schuylkill a much larger utilization is made. In fact, the records show that in 1909 the yield of the river at Fairmount dam was less than the present total draft on it by the City of Philadelphia. The flow during that drought was estimated to be 115 million gallons per day for 30 days, and while there seems to be some reason to doubt the accuracy of that record, it is safe to say that more recent measurements and studies indicate a minimum low water flow for one week of no more than 180 million gallons per day.

The progressive draft on this river within the region is as follows:

At Pottstown	2.0 million gallons daily
At Royersford and Spring City	.5 million gallons daily
At Phoenixville	1.0 million gallons daily
At Norristown and Bridgeport	5.0 million gallons daily
At Philadelphia	<u>171.0</u> million gallons daily
Total Draft	179.5 million gallons daily

It is doubtful if there is a river of similar size in the United States, undeveloped by storage, which is utilized more intensively and completely for water supply than the Schuylkill. Certainly as far as the City of Philadelphia is concerned it has reached the limit of utilization, unless development by storage on either the main stream or tributaries, can increase the present minimum yield.

The use of the tributaries of these two rivers for water supply purposes has progressed similarly. Some have been developed by construction of impounding reservoirs to yield close to the maximum that economically may

be expected. The two outstanding examples are Pickering Creek and the new Crum Creek supply. Those that have not been developed to any great extent, and which are approaching, quantitatively, limits of use in their present state, are the Brandywine, Neshaminy, Ridley and Chester creeks. The data regarding these supplies are shown in Table 3 and outlined further in succeeding pages of this report.

Underground Sources of Supply

Water supplied from underground sources in the region is largely for the City of Camden and adjacent territory. Out of a total of 37 million gallons per day from such sources, 33 million gallons are drawn from wells in New Jersey, mostly in Camden and Gloucester counties. There are a few scattered well supplies in Pennsylvania and some in Delaware.

These wells range in depth from 35 feet to 660 feet and generally may be said to draw water from the same strata. This is known geologically as the Raritan formation which has a dip southeastward to the coast line of New Jersey of about 50 feet to the mile. The draft on this formation is growing yearly at a rate of between 3 and 4%. While estimates are not available as to the ultimate yield of this formation, it is already evident that the yield of some wells is affected by the draft on others some distance away. There is already an apparent definite lowering of the water bearing level.

The indications from a regional point of view are that the present sources of supply, both from surface streams and underground, in critical sections of the region, are close to the present safe yield of the several supplies. The notable exceptions are the Delaware River proper, in which the quantitative margin is large, and in the possibilities inherent in further or new development of tributary streams. There are, however, qualitative considerations in each of these supplies, especially the Delaware River, which may or may not limit the use of these sources which are so evidently satis-

factory from a quantitative point of view.

Pollution of Surface Supplies

A study of the Sewerage Map on page ____, reveals the extent to which existing surface water sources are endangered by pollution from upstream communities which discharge into them. The following municipalities use water into which sewage has been emptied from established municipal sewerage systems above each one:

<u>Source of Supply</u>	<u>Municipality</u>	<u>1920 Sewered Population Above Each Municipality</u>
Delaware River	Trenton	175,000
" "	Morrisville	175,000
" "	Bristol	323,000
" "	Burlington	333,000
Neshaminy Creek	Phila. Suburbs (North of City)	9,500
Delaware River	Philadelphia	356,000*
Schuylkill River	Pottstown	113,000
" "	Spring City	132,000
" "	Royersford	132,000
" "	Phoenixville	132,000
" "	Norristown	137,000
" "	Bridgeport	137,000
" "	Philadelphia	171,000
Delaware River	Chester and suburbs	3,137,000
Brandywine Creek	Wilmington	30,000

* Minimum, - Maximum is dependent on stage of tide.

In the above table each community has been arranged in relation to its position on the watershed of the Delaware River or tributary, so as to show progressively the population sewerage into each source of supply from above. For example, the community farthest down stream must filter and sterilize the water that has received sewage and industrial wastes contributed by the population of all those sewerage communities situated upstream. A complete list of these communities is shown in Table 8.

However, it must be remembered that the seriousness of the situation presented by such a large sewerage population load on the stream is modified by two factors:

1. The degree of treatment of the sewage
2. The natural oxidizing and assimilating powers of the stream and dilution

Many of these communities already treat their sewage before discharge into the public waters, but the degree of treatment seldom goes beyond that of plain sedimentation. Removal, by this process, of the solid putrescible matter is a long step forward but the bacterial load is not necessarily lightened and there are still the dissolved organic matters to be reduced after discharge into the stream. The powers of the stream to assimilate sewage are determined by the degree of dilution afforded, the dissolved oxygen content, the temperature of the water and the time interval. When water intakes and sewage outlets are in close proximity to each other the extent of natural purification is entirely dependent on the dilution factor. This phase of the pollution question is outlined in the section devoted to Sanitation together with the steps which have been taken to mitigate stream pollution.

In 1922 a joint agreement was made between Departments of Health of the States of New Jersey and Pennsylvania which was designed to control the degree of treatment required for sewage which was to be discharged directly

into the Delaware River in each state. Also, the Sanitary Water Board of the State of Pennsylvania, after its formation in 1923, inaugurated a classification of all streams in Pennsylvania as a basis for requirements regarding the degree of treatment of sewage discharging into the respective streams. Detailed references to these two subjects are made under the Sanitation section of this report.

Sub-Surface Pollution

The danger of pollution to underground sources of supply in the New Jersey portion of the region is influenced by the filtering properties of the soil, the density of population on the catchment area and the disposition of sewage thereon.

The Raritan formation, from which such a large portion of the supply is drawn, is apparently fed by seepage from rainfall on the land and from the water courses, overlying a strip of territory about ten miles wide extending from Trenton to Pennsgrove and including the Delaware River. What bearing the pollution of the Delaware might have on this supply has never been determined, but several wells drawing from this, or related strata, have been condemned recently by orders of the New Jersey Department of Health, because of their polluted condition. The possibilities for contamination of deep wells by seepage around or through casings from overlying strata is a constant danger, though protected by stringent regulations regarding the manner of driving such wells. During excavation of the foundations for the deep piers of the Delaware River Bridge, the water seeping in at the bed rock level was found to be contaminated, but the exact level of the source of the pollution was not established. It is evident, however, that a polluted condition of the surface streams and the growing population density on the catchment areas may be expected to have its effect on the purity of underground supplies.

Present Use of Water

For the purpose of this study, the territory within the region has been subdivided into four units, according to the natural characteristics which suggest their separate consideration.* (see below) These units roughly may be described as the sub-regional areas of Philadelphia, Camden, Trenton and Wilmington, the boundaries of which have been outlined on the accompanying map showing the principal watersheds. In each of these areas there are closely related problems of water supply determined by the physical characteristics of each, and the amount and distribution of population. Also each roughly corresponds with important watershed or natural drainage boundaries and hence lends itself to isolated treatment from the water supply point of view.

***Note:--** In the final draft of this report, it is proposed to change these sub-regional areas to conform entirely to State and County lines for which population estimates have been presented elsewhere in the Regional Plan Report. The new division would be as follows:

Pennsylvania part of the Region

Philadelphia County

Bucks, Chester, Delaware and Montgomery counties

New Jersey part of the region

Mercer County

Burlington, Camden and Gloucester counties

Salem County

Delaware part of the region

New Castle County

While not as satisfactory a division of the region in some respects as the former, due to overlap of certain supplies across County Lines, it is believed the above division will serve a more useful non-technical purpose.

The problem in the balance of the region, outside of the sub-regional areas described, is made up largely of numerous individual problems related to the region only insofar as they affect stream pollution; or are in territories potentially desirable for development of water resources for the more densely populated metropolitan areas.

Population Served. The estimated population in the four sub-regional areas is 3,237,000 and of these 97.5 per cent are at present receiving a supply of water from public sources. The remaining 2.5 per cent represents that portion of the population living in scattered communities within these areas or between built-up territories. They represent the potential future users of water who will promptly require service as the built-up areas expand. This process of inclusion, in part, may have been responsible during the last few years for the greater increase in water consumption than in the rate of population growth.

The following gives the 1930 population of each sub-regional area according to the United States census, the density in population per square mile, and the per cent of the total now receiving a supply of water from public sources.

	<u>Population</u> <u>1930</u>	<u>Density</u> <u>per Sq. Mi.</u>	<u>Per cent</u> <u>Served</u>
Philadelphia Sub-Regional Area	2,489,742	3432	97.7%
Camden " "	364,740	818	93.3%
Trenton " "	215,289	546	74.9%
Wilmington " "	<u>167,229</u>	<u>442</u>	<u>77.7%</u>
Total	3,237,000	1665	97.5%

Per Capita Demand. Population statistics in the several parts of the region give only a general idea of the relative water needs of each section. The per capita consumption and total use of water as taken at the

source furnishes a more direct index of the present needs for water supply. For the four principal districts described and the outlying territory, the following table shows how the per capita consumption varies:

	<u>Population Served 1930</u>	<u>Total Consumption at Sources (Gallons)</u>	<u>Per Capita Consumption Pop. Served (Gallons)</u>
Phila. Sub-Regional Area	2,435,000	391,500,000	161
Camden " "	340,000	31,800,000	93
Trenton " "	161,000	19,300,000	120
Wilmington " "	<u>130,000</u>	<u>16,400,000</u>	<u>126</u>
Total for Sub-Regional Areas	3,066,000	459,000,000	150
Outlying Territory	<u>84,000</u>	<u>7,700,000</u>	<u>92</u>
Total for Region	3,150,000	466,700,000	148

From an examination of the data in Table 2, it will be seen how the per capita consumption varies for each community or supply and how each of these influence the rate in the several sections of the region.

The wide variation in per capita consumption in the various parts of the region is due largely to the use of public water supplies for industrial purposes. Deducting the total amount used by industries, for the cities listed, from the total consumption in the region, the domestic and commercial use of water is _____ gallons per capita. This average for the region then varies much less radically from the rate in the suburban and smaller communities. Wherever statistics have been available, the use for industrial purposes has been summarized and given for the principal cities in the region in the following table:

Per Capita Consumption - Gallons per Day

	<u>Industrial</u>	<u>Domestic and Commercial</u>	<u>Total</u>
Philadelphia	54(est.)	110 (est.)	164.0
Trenton & Suburbs	23.2	97.6	120.8

Per Capita Consumption - Gallons per Day (cont'd)

	<u>Industrial</u>	<u>Domestic and Commercial</u>	<u>Total</u>
Wilmington	46.3	84.5	130.8
Chester and vicinity			81.3
Camden	44.3	105.8	150.1
Norristown and vicinity	<u>26.0</u>	<u>81.9</u>	<u>107.9</u>
Total by per cent			100 %

Another factor accounting for the high domestic and commercial rate in the principal cities is the added day time population which comes in from suburban areas to work, shop or for other reasons, thus decreasing the rate in those areas. The passenger traffic origin and destination survey showed that nearly 300,000 persons came into Philadelphia from points outside the city, thus adding 15% to the resident city population. Similarly there were added over 75,000 to the 350,000 combined populations of Camden, Trenton and Wilmington. These figures are, of course, modified somewhat by an outward, but very much smaller, daily flow of city residents.

Private Industrial Supplies. Many industries and manufacturing establishments, particularly the utilities, use large quantities of water obtained privately from wells or adjacent streams. No survey was made of the amount of this use, but it is known to be large and exceedingly important. The three railroads in the region alone use 15 million gallons per day from independent sources. Were such quantities as these added to the per capita consumption for industry, as taken from public supplies, it is quite probable that the industrial per capita rate would equal or exceed the domestic and commercial rate.

In the Water Resources Inventory Report of the Water Supply Commission of Pennsylvania, published in 1920, Part VI, Table 16, Page 47,

gives figures for the Lower Delaware Basin which comprised almost all of the Pennsylvania part of the Tri-State District and about 30% additional territory. The consumption was estimated to be 442 million gallons daily, of which 196 million was for domestic purposes and 246 for industrial purposes. About 100 million gallons of the industrial supply, however, was stated to be privately obtained. With a then estimated population served (1915) of 2,149,000 the consumption from public sources was at the rate of 159 gallons per capita per day, of which 68 was for industrial use and 91 for domestic and commercial purposes. If the private industrial consumption is added to the public industrial use, the industrial per capita rate would be 114, or 25 per cent greater than the domestic rate.

While these figures are for Pennsylvania only, they illustrate how large an amount of water is used in industry and how important an adequate and pure supply of water is to the business life of the region.

Methods of Distribution

There are 97 systems for distribution of the public water supply of the region; 44 of which are municipally owned and supply 92 per cent of the total water used; and 53 of which are privately owned and supply 8 per cent of the total. However, on the basis of the territory which they are chartered to serve, the privately owned public systems cover a much greater area and number of political sub-divisions than do the municipally owned systems.

This is especially true in the suburban territory adjacent to Philadelphia and Camden. The four principal privately owned systems in this area supply water as follows:

<u>Company</u>	<u>Sq. Mi. Served</u>	<u>Population Supplied</u>	<u>Political Units Supplied</u>
Philadelphia Suburban Water Co.		305,000	49
New Chester Water Co.		74,000	10
Norristown Water Co.		45,000	7
New Jersey Water Co.		55,000	11
Total - above 4 companies		479,000	77

	<u>Sq. Mi. Served</u>	<u>Population Supplied</u>	<u>Political Units Supplied</u> (cont'd)
Total - other 49 companies		118,000	78
Total - privately owned in Region		597,000	155

These figures are taken from Table 2 and indicate that these four companies serve 80 per cent of the population and about 50 per cent of the political units as supplied from privately owned systems. All privately owned systems together supply only 19 per cent of the total population served with water.

The significant fact about privately owned systems as indicated above is that they provide an exceedingly flexible organization for furnishing water supply to fast growing detached and small suburban units which would find it physically and economically difficult to obtain and distribute supplies individually. Furthermore, distribution reservoirs can be built to serve whole sections instead of single municipalities and at sites geographically suited. Water service often can be offered to encourage decentralization of suburban development instead of concentration, as is the case in the Philadelphia suburban area.

Table 6 shows the progressive growth of privately owned distribution systems. This has taken place mostly within the past 25 years, through the acquisition by private interests of charters and by financial control.

In contrast with the rapid expansion in the number of political units served by single privately owned systems in the region is the natural reluctance of the municipally owned systems to give service very far beyond their corporate limits. Trenton is the outstanding example of liberality in this service, supplying over 24,000 outside the city, though at net rates somewhat in excess of the city rate. Wilmington does likewise. It is right that municipalities should charge more for these extensions, for often,

among other reasons, part of the costs of water are absorbed in the general tax rate.

Protection of Surface Supplies

The fact that 92 per cent of the total regional water supply is obtained from surface sources makes it exceedingly important that these existing watershed lands, and those contemplated for future supply, be protected and conserved in every possible way. The advantages are obvious in having a definite program for protecting and controlling the use of undeveloped land tributary to a surface water supply, instead of abandoning such properties to the whim of many small private owners with probable subsequent irreparable damage as a catchment area for public water supply.

There are apparently two methods for protecting surface water supplies: The first and most common is by ownership of all the land needed for control of its development or for forestation of the area within the watershed. This may be held by either the municipality or the company interested and kept in a wild undeveloped state.

The second method, which is of growing popularity, is concerned with acquisition of the necessary land for a coordinate and two-fold purpose. It may accomplish practically all that is intended under the first method and in addition under strict sanitary control, provide limited recreational facilities for the use of adjacent urban population. This method seems to be particularly applicable to the Tri-State District.

Today there is no outstanding example in the Region where extensive lands have been bought for any more than adjacent protection of water supply properties. The 3600 acres controlled open space in Fairmount Park, insofar as it prevents the direct encroachment of built-up territory to the very shores of the Schuylkill River, acts in a measure as such local protection. Considering the size of the watershed, it contributes only a small part to

its preservation as a source of water supply. Contrasting the Philadelphia Region with the New York Region, where, in 1927, there were owned 57,000 acres of municipal watershed properties as against 90,000 acres of public parks, it is evident that this region is decidedly remiss in adopting means to protect its present and future water supply. Of course, the two regions are not exactly comparable in this respect as of the same date, but it can be safely predicted that similar measures will be needed in the Philadelphia Region as population increases and spreads out over the adjacent watersheds.

The possibilities for coordinate use of water supply properties for public recreation were endorsed by Mr. W. L. Stevenson, Chief Engineer of the Pennsylvania Department of Health, in an address before the October meeting of the Pennsylvania Water Works Association in 1927. After reviewing the trend of public opinion, which was pressing for the right to temporarily use these watersheds for fishing, camping, hunting, picnicing, hiking and the like, and contrasting this demand with the necessity and obligation of water supply companies and municipalities to maintain a safe and pure supply, further complicated by the riparian rights of the owners to the reasonable use of these streams, he said:

"There are certain streams in the State used as sources of public water supplies, principally the rivers and major tributaries, draining developed areas, having a relatively large volume of flow, used with a maximum of purification measures and where filtration of the water is the almost universal practice, wherein recreational use might be permitted with reasonable safety.

"The other extreme is a class of streams, usually the smaller ones, draining an undeveloped area, having a relatively small volume of flow, with a minimum of purification measures and no long time storage. Here it is somewhat obvious that the safety of these supplies depends upon absolute prohibition of the use of the watershed for recreational purposes.

"In between these two, there are many streams not falling into either of the aforementioned classifications, where possibly recreation could be permitted under certain restrictions.

"It is quite evident, therefore, that there can be no blanket regulation on this subject having state-wide application. Local conditions will have an effect upon each case."

It is obvious that no general rule or principle regarding such limited use of watershed properties can be laid down, but it is equally evident that in a region like the Philadelphia Tri-State District, the dangers from lack of control of the character of development of other properties on the watershed and along the stream are more dangerous than would be the use temporarily of such lands by the public when under very definite sanitary supervision and limited as to character of permanent development. Large reservations on water supply watersheds are needed far more on such tributary streams in the Tri-State District than on the Delaware and Schuylkill, even though the major portion of the surface supply is obtained at present from the latter two. The tributaries are the potential future supplies.

Recommendations Made for Regional Open Space Reservations.-- To more adequately protect the watersheds of important tributary streams in the region now used or proposed for use as water supplies, as well as to provide recreational areas, the Regional Plan in the report on Parkways and Public Reservations has recommended the acquisition of open space reservations along the following streams or within their drainage areas.

<u>Stream</u>	<u>Area of Open Space</u>
* Brandywine Creek	
* Chester Creek	
* Crum Creek	
* Ridley Creek	
* Pickering Creek	
Perkiomen Creek	
French Creek	
* Neshaminy Creek	
Tohicon Creek	
* Crosswicks Creek	
Rancocas Creek	
Wading River	
Mullica River	

Note:-- * Indicates streams already directly used for water supply.

While some of these reservations are on streams not now directly used for water supply, they have been proposed for such future use at one time or another. Their adaptability for this purpose in the future will be directly dependent on the degree of protection that will be possible and feasible when such use becomes desirable. Farsighted planning, backed by acquisition of these lands in the immediate future, will save the public many millions of dollars at a later date, besides preserving most valuable and suitable open space area for present and future use.

An instance of the cost of delay in such acquisition may be cited in New Jersey. In 1915 a bond issue for a million dollars was submitted to referendum vote for the purpose of purchasing wild undeveloped pine lands in the headwaters of the Wading and Mullica rivers. The purpose was to preserve for public water supply use the watersheds of these two streams, capable of being developed to yield 200 million gallons per day. The issue was turned down and now it is apparent that the State will have to pay several times this amount for the same property, large portions of which have since undergone serious damage to timber growth by fire, thereby destroying some of its value as desirable water supply property.

Value of Forestation.— Forestation is important in preserving the value of watershed lands. The following shows the equivalent amounts of rainfall used during the growing season by certain types of vegetation and trees:*

Fir or Pine	-	4" of rainfall
Maple or Oak	-	8" of rainfall
Wheat or Grain	-	10" - 15" of rainfall
Grass	-	30" - 40" of rainfall (if furnished)

With a total rainfall of roughly 40" annually available in the Tri-State District, it is apparent that a watershed given over to farming and grazing would yield little water to the stream except in times of intense

*Note:- Compiled from Turnelaure & Russel, "Public Water Supplies", P. 61 1908 edition.

storms or in the spring of the year. The value of forest cover lies in the small amount of water actually used by the trees and the high retention value of the humous on the forest floor.

While the above values are the result of careful and scientific experiment, they have never been fully verified on a large scale. The Allegheny Forest Experiment Station of the U.S. Department of Agriculture is now proposing to conduct experiments over a long period of years to discover the effect of cover of various kinds on the run-off of watersheds.

Protection by Zoning Instead of Acquisition.— If it were possible to zone against certain uses of watershed lands, as is done abroad and has been proposed here, it might not be necessary for the public to actually acquire so much land for protection. Open space area with a low density of population and adequate forest cover is the paramount requirement and the best means to this end is what is needed. The late Mr. Allen Hazen, noted Hydraulic Engineer, in discussing the situation in the Boston Metropolitan District, stated:

"What we need for the state is something corresponding to the zoning of cities. That is to say, setting aside areas for future water supply and preventing industrial and suburban developments upon them, not with the idea of reducing future population and industry in the Commonwealth, but of requiring it to go to areas which are not restricted in this respect. There is plenty of land in the Commonwealth for all the development in sight, and this is equally true, if all land needed for future water supply is taken for such development.

"At present the only certain legal method of securing this result is by the immediate purchase of such lands and rights as are necessary for the reasonable control of areas for future development."

Present Regulation and Control of Water Supplies

Scope of Authority.— The several States hold the original authority for regulation and control of water supplies, though in actual operation the established municipal or private organizations are given wide authority and responsibility for the operation of their individual systems. The States, however, exercise their jurisdiction by requiring regular reports of operating

conditions and periodically inspect each system. All plans for extensions or improvements to existing systems, or the construction of new systems, require the approval of generally more than one department of the State and the issuance of a permit.

Methods of Regulation.-- Regulation and control may be summarized under four functions:

1. Location of source and quantity of water used.
2. Quality of water at source and as delivered.
3. Extent of chartered territory.
4. Rates charged for water.

Each state has a separate department for exercising its powers of control over each one of these functions, with more or less active coordination between them, depending on the circumstances.

Control in Pennsylvania.-- In Pennsylvania, the Department of Forests and Waters, through its executive arm, the Water and Power Resources Board, upon request or demand, apportions the source of supplies and approves applications involving charters and the diversion of waters from their natural channels, whenever it has jurisdiction. The powers and duties of the Board are divided with those of the Water Resources Service, also a Bureau in the Department of Forests and Waters, and which are chiefly regulatory and administrative in character.

The quality of water delivered to the public is regulated by the State Department of Health through the Bureau of Engineering. Through its control over permits for waterworks, it has set certain standards of purity which must be met. Activities within the Tri-State District are directly administered through a Division Engineer, whose jurisdiction coincides with the boundaries of the region. The Sanitary Water Board, another administrative arm of the Department, administers the anti-stream pollution laws, and

makes investigations of the ways and means of preventing pollution of the waters of the State. No regular official report has been issued recently by either the Bureau or the Board as to its activities, though a popular pamphlet on health subjects is issued monthly.

The Public Service Commission in Pennsylvania is the regulatory power determining the rates that may be charged for service by privately owned public water supply companies, and controlling the adequacy of service. It has no rate jurisdiction over municipally owned supplies. The Commission requires the filing of an annual report giving the financial structure of the company and a general inventory of the system. No annual report is published giving the status of these companies. A schedule of rates for each company is required to be publicly posted.

Control in New Jersey.— In New Jersey, the State Water Policy Commission, established in May, 1929, has exceedingly broad and comprehensive powers over the water supplies of the State, originally held in part by the Department of Conservation and Development. It is generally charged with the duty to "conserve, protect, control, and regulate the use, development and diversion of surface, sub-surface and percolating waters of the State". In addition, it is given specific charges to investigate all the water resources of the State to the end that all developments may be coordinated and unified in the interest of economy and service. Condemnation of land or water must receive its approval whether by municipal or private corporation. All plans for additions to existing systems or supplies and for the construction of new supplies must receive its approval. It can require the inter-connection of systems in the public interest. Finally, it is charged with the duty to prepare a comprehensive plan for the conservation, development, regulation and use of the waters in each of the principal watersheds of the State for the purposes of water supply, sewage disposal, prevention of floods, drainage and irrigation, water power and protection of public navigation.

The powers and duties of the Bureau of Engineering in the New Jersey Department of Health are somewhat similar to those of the corresponding Bureau in Pennsylvania. Regular reports must be filed and annual inspection made of every system. Activities are all administered from Trenton. An annual report is submitted and published, giving the status of water supplies in the State.

The Board of Public Utility Commissioners with headquarters in Newark is the arbiter in determining rates and requires the filing of an annual statement by each company and municipality, giving facts about the Water Service pertinent to the rate schedules. These latter are published as in Pennsylvania. The New Jersey Board, however, goes further and issues an annual statistical report summarizing important facts as to financial structure and physical conditions of interest to the public.

Control in Delaware.-- In Delaware, due to the smallness of the state and the fact that the population is concentrated in a relatively small number of communities, the Division of Sanitation of the Board of Health is the only state body having jurisdiction over water supply. Its activities are similar, in general, to those of the other states. Under a recent law, plans for new water supplies must be submitted to this Board. A published annual report gives a general statement of the work of the Division in each community. Activities are directed toward helping the smaller communities solve their own peculiar problems, even to assistance in drawing plans and supervising work.

There is no regulatory commission on rates in Delaware nor is there a Department assigned to the study of Water Resources.

Summing up, it may be said in all fairness that New Jersey probably has the most comprehensive and modern programme in regard to water supply. The new State Water Policy Commission promises to do outstanding constructive

regional work in preparing a comprehensive plan. Probably the dense population of the state and its exceedingly rapid growth has brought it, of necessity, to this more advanced stage.

The Problems of the Future

If the experience of the past is any criterion, there will be inevitably the necessity for providing more and more water for populous areas in future periods. Not only is population growing in numbers at more or less definitely predictable rates for large economic unit areas, but the use of water in certain sections is increasing at rates in excess of the population increase. Furthermore, there is probably no other major facility or necessity of modern life, for the large cities at least, that requires more definite long range planning and early commitment than those providing for the collection and distribution of an adequate water supply.

Population Forecasts

The recent United States Census just completed has indicated a population growth for the Tri-State District of 15.1 per cent for the last decade, contrasted with 20.2 per cent for the previous decade 1910-1920. Studies of the past show that the regional rate of population growth has been diminishing each decade since 1850, while numerically the numbers added each period have been on the increase. The amount by which the population increases is, however, rapidly approaching the point where, in actual numbers, at least, the increase for each decade may reach a maximum and perhaps be on the decline thereafter.

Probable 1980 Water Requirements in the Region

The importance of this fact from the water supply point of view is that the region will shortly reach the stage of maximum decadal water demand, estimated at roughly 60 million gallons for a population increase of five to six hundred thousand per decade in the immediate future. Fifty years hence,

in 1980, the indications are that the regional population will be 6,466,000, representing a growth of 2,936,000 people or an increase of 83 per cent. This would mean an additional water supply in the next fifty years, at an estimated rate of 109 gallons per capita for these additional 2,936,000 people, of about 320,800,000 gallons per day or 68.7% increase over the present supply.

Anticipated Conditions in the Sub-Regions

Population Distribution.-- Before any idea may be obtained of the probable sources of this additional supply, it is necessary to make some estimate of the probable distribution of this population and where the additional water will need to be delivered. The accompanying sets of curves indicate what future population might reasonably be expected in each of the sub-regional areas,* based on their past growth and controlled in total by the master curve for the Tri-State District, also shown.

Periods for Which to Plan.-- For planning purposes, estimates of future water supply needs should be made specifically 20 years and rather generally 50 years in advance. The former represents the date for which definite plans must be laid down in the next ten-year period, for it is generally conceded that large water supply projects require five to ten years for completion. This has been the experience of New York City, the North Jersey Metropolitan Area and the Boston Metropolitan Water District. The ultimate requirements, as gauged from those about 50 years hence, when the population unit will be more nearly matured and will be approaching saturation should have a definite bearing on the type and extensiveness of plans undertaken for the immediate future 20-year period. Accordingly, the years 1950 and 1980 have been chosen as the critical ones for comparison of future needs with those of the present.

Factors Affecting Future Consumption.-- The estimated population of each sub-regional area* for 1950 and 1980 has been taken from the curves

* See Note on page 14

and, after applying a factor for the per cent that probably would be served at these dates, the population to be supplied with water has been tabulated in Table 4. It was assumed that the per cent served would increase proportionally to the density of the population in the area. The future water requirements were obtained by assigning a per capita consumption rate, commensurate with present usage and metering, these rates being reduced somewhat to allow for economies to be expected in additional metering as well as further efficiencies in the distribution and use of water. While the future quantities thus arrived at are based on these necessary assumptions, and consequently subject to error, it is felt that they provide a moderately accurate yardstick for use in foreseeing the probable future needs.

Requirements for Each Sub-Region.* A summarization of the important facts brought out in Table 4 is listed below. Instead of tabulating the total water requirements for 1950 and 1980 as in the table, the increments to be expected over present (1930) usage are shown:

	1930 Consumption	Additional Supply in 1950	Needed Over 1930 in 1980		
		M. G. D.	Per cent Increase	M. G. D.	Percent Increase
Phila. Sub- Regional Area	391,500,000	87.5	22.4	206.9	52.8
Camden Sub- Regional Area	31,800,000	19.6	61.6	71.4	224.3
Trenton Sub- Regional Area	19,300,000	8.1	42.0	22.7	117.7
Wilmington Sub- Regional Area	<u>16,400,000</u>	<u>3.3</u>	<u>20.2</u>	<u>9.4</u>	<u>57.4</u>
Total for Sub- Regional Areas	459,000,000	118.5	25.8	310.4	67.6
Outlying Territory	<u>7,700,000</u>	<u>2.8</u>	<u>36.4</u>	<u>10.4</u>	<u>135.0</u>
Total for Region	466,700,000	121.3	26.0	320.8	68.7

* See Note on page 14

Due to the variations in the expected rate of population growth in the different areas, and to changes in the per cent of population served as well as reductions in per capita consumption, the net influence of all these factors is reflected in a wide divergence in the per cent increase of water consumption for all areas. The increase in the Philadelphia area is the lowest because the population served at present is nearly 100 per cent and the largest saving in per capita consumption is expected. However, the quantitative increase in both the Philadelphia and Camden areas is by far the greatest, for they are the centers of the Region and will have the largest numerical population increase.

Sources of Future Supply

Generally speaking, each sub-regional area has natural sources to which it can turn for future supplies. The Philadelphia area may increase its draught on the Delaware, provided the quality of the water is assured; or it may turn to upland sources, such as the Neshaminy, Tohickon and Perkiomen, and the tributaries of the upper Delaware and Lehigh, which have been recommended repeatedly, together with some further development of existing smaller tributaries within the area. Other communities, now drawing upon the Delaware and Schuylkill rivers may find it expedient to join in some coordinate development of these upland sources. In any case, the necessity for this step will be determined largely on the satisfactory quality of Delaware and Schuylkill water in future years as a continued source of supply. The influence of expected population and industrial growth in these valleys on the quality of the water is outlined in the following section dealing with Sanitation.

The Camden area can doubtless draw additional quantities from underground strata and eventually look to a surface supply developed in the pine lands on the Wading, Mullica or Rancocas rivers, if present sources diminish or become unsatisfactory.

Trenton has the Delaware above tidewater, again guaranteed only if the quality of the water is protected.

Wilmington and adjacent territory could obtain sufficient water from the Brandywine, provided it were possible to develop this stream within the State of Pennsylvania. The city has recently completed in Delaware construction of a large storage reservoir on Old Mill Creek, a tributary of Red Clay Creek, and it proposes to pump a dry weather reserve into this reservoir during periods of more plentiful flow in the Brandywine. This will insure the city an adequate supply for some time. Further provision for future needs might be obtained if the city was permitted to develop the resources of the Brandywine or its tributaries within Pennsylvania. This could be done by the adoption of a compact between the two states or by concurrent legislative action. It might even be possible to provide for the formation of a private company under Pennsylvania charter and with stock owned or controlled by Wilmington, which would allow for development of water resources outside the State for the benefit of Wilmington and adjacent territory. There are several good precedents to such action, among them being the development of Ebbits Creek in Pennsylvania for the water supply of Cumberland, Maryland, and the development of Conowingo power on the Susquehanna River in Maryland for the advantage of Philadelphia.

The outlying territory in the region presents no special regional problem of water supply, due to the low density of population and slower growth, except as such of its existing or potential natural sources of supply are needed for the several more densely populated sub-regional areas. The States should enact legislation providing for the protection of these communities and private interests and for the equitable distribution of water developed from these resources.

A study of Table 5 indicates that the combined resources of these, at present practically undeveloped rivers and creeks, would provide sufficient quantities of water to meet the requirements of the expected population in 1980. That is, if these sources are qualitatively desirable at that date.

THE KEY TO THE SITUATION

Quality of Water Resources the Criterion

While it is obvious that this Region is blessed with plentiful quantities of once potable water, this very fact has led to such abuses of its water resources that the potentially potable supply has been reduced to the danger point. It is comparatively easy to forecast the 1980 requirements, but to estimate what sources will be fit for water supply purposes at that date is quite another matter. The question of pollution is thus the crux of the water supply problem.

Density of Population on Watersheds.- The City of Philadelphia, in making a safe drinking water out of the bacteria loaded and chemical mixture in the Schuylkill and Delaware, has accomplished an outstanding engineering feat. Few other large cities have an equivalent polluted source of water supply. The tendency of modern policy, however, has been to abandon such supplies and seek relatively pure upland sources on whose watersheds there is a low population density. Thinking in terms of the future, therefore, it is desirable to look to those areas in or near the Tri-State District which will most likely have a low density of population either through natural economic causes or which can be controlled easily by acquisition or legislation. These, in a general way, correspond with the recommended sources that have been proposed from time to time and are shown on the Water Supply Map in this report.

It is worth noting the experience of the New York Region, in having its water supplies endangered by the outflowing spread of population. Back 30 years or more, when many of the present supplies were being developed, they

lay on the fringes of the populated areas. Today those watersheds that lie in Westchester County, New York, and Passaic, Morris, Essex, Bergen and Union counties, New Jersey, are becoming populated at an alarming rate. On the Pequannock watershed used by Newark, it has been necessary to acquire 80% of the watershed and actually pay the cost of depopulating some of it.

The application of this experience to the Tri-State District lies in the necessity for controlling the spread of population over those watersheds which are going to be needed for future supplies. The urgency of such action is going to be augmented as time goes on, because present sources on the Delaware and Schuylkill may then have such a high population load, that even with sewage treatment, they will become less desirable for increased future supplies. The present densities of population on all present by developed and proposed future watersheds are listed in Table 5.

Spread of Industry.-- Another factor influencing the usable sources of future supply will be the spread of industry. There can be little doubt that industrial enterprises will continue to seek locations along important waterways where they find both rail and water transportation as well as an independent water supply for manufacturing purposes. It is highly probable that the future will find industries desiring to develop their own water supplies from nearby rivers, like the Delaware and Schuylkill, in the interests of economy, while municipalities will look to the tributaries for a better quality supply for human needs.

Diversion of Water to other Watersheds

The practice of diverting water from one large watershed to another, for purposes of supplying large population centers whose own watersheds are inadequate or unfit for use, may affect both quality and quantity of water supplies. Whether such diversion is an asset or not to other communities, dependent on the same stream for their supply, depends entirely on the manner

in which the diversion is accomplished. For if compensated flow is provided, by storing water in times of heavy rainfall, it may even be possible to increase the low water flow of the stream and be beneficial to the quality in spite of the diversion, though, of course, the mean yield of the stream would be reduced.

Two cases of proposed diversion affecting the Tri-State District have come up within the last five years. The most important was the proposal of New York City to divert 600 million gallons daily from the upper Delaware for augmenting the city's present supply of about one billion gallons a day. This matter, affecting the rights of the states of New York, New Jersey and Pennsylvania has been settled recently by decree of the Supreme Court of the United States. The other instance of proposed diversion, while of much lesser magnitude, involved the respective rights of a municipality and a private corporation serving the public, to certain flows in the Perkiomen Creek. The decision here, lay with the Montgomery County Court.

The Delaware River Case.-- The decree of the Supreme Court of the United States, upholding the report of the Special Master and granting to New York the right to divert no more than 440,000,000 gallons daily from New York tributaries of the Delaware River under certain conditions, is one of the most important decisions with reference to interstate water rights handed down in modern times. An eminent array of engineering and legal talent was mustered in the hearings before the Special Master appointed by the Court. The decree was based on the principle that the common law rule governing the right to divert running water as between upper and lower riparian owners in the same State is not strictly applicable as between States, since different considerations, such as the welfare of the whole population, are involved where the controversy is between different States. The Court stated that the applicable rule is that of equitable apportionment so that the interests of both States in the water could be reconciled if possible.

It is interesting to note that the basis for reducing the amount of permitted diversion was because of the effect that an amount, in excess of that allowed, would have on the use of the river for recreational purposes and upon the oyster fisheries. It was determined, furthermore, that the proposed diversion would not have materially affected the river, its sanitary condition or its use for municipal water supply, industrial or shad-fishing purposes. It is striking, therefore, that the two considerations with which a regional plan is most concerned, namely the welfare of the whole people and the protection of natural endowments for recreational use were the chief governing elements in the decision.

In this case the State of New Jersey was plaintiff and the State and City of New York, defendants. The Commonwealth of Pennsylvania was admitted as intervenor, solely to protect its interests, and in the endeavor to have adopted the doctrine of equitable apportionment so that, among other reasons, eastern Pennsylvania, and Philadelphia in particular, might have the use of the waters of the upper Delaware and its tributaries, as a source of water supply in the future.

Diversion from Perkiomen Creek.— The proposal of the Philadelphia Suburban Water Company to divert water from the Perkiomen to its system of distribution serving suburban Philadelphia was opposed by the City of Philadelphia on the grounds that it would impair its supply in the Schuylkill at Philadelphia. Unlike the Delaware River Case, the decree restraining the diversion under certain conditions of low water flow was based largely on the doctrine of riparian rights and certain other rights established by charter, condemnation, or long usage.

The Need for Water Supply Policies.— This case is of interest to the Regional Plan because of the necessity it evidences in Pennsylvania for a means of equitable division of such water resources as may be desirable

for water supply purposes. The Perkiomen has long been proposed as a future source for Philadelphia upon abandonment of the local sources in the Schuylkill or Delaware rivers. The City, however, has never adopted any policy in this respect and because municipalities have no right of condemnation, as do certain water companies chartered prior to 1907, except by purchase of riparian lands, it is evident that the potential developable supply from this source by the city is now reduced by the amount of water condemned and allowed to be diverted under the foregoing action.

Without prejudice to the equity of deciding such matters under existing law and by court decree, due to future requirements there will be obviously a growing need for complete and technical public control over the division of water resources that they may be equitably allotted and conserved for the use of both public and private interests.

Under the act establishing the New Jersey State Water Policy Commission, approval of every new water supply project must receive the sanction of the Commission. It is assumed that with a comprehensive plan for the development of the State's water resources at hand, they are the logical and best informed authority to judge as to the effects of one particular proposal in relation to all the others and the common welfare. The Supreme Court of the State remains for appeal. New Jersey, however, has always maintained control even under earlier commissions of its so-called "diversion rights" going so far as to charge for "excess diversion" when additional requirements went above a certain amount. Thus, this attitude has centered from the start the responsibility of the State in the division of its water resources, resulting in an active and positive policy.

The fact that New Jersey, now ranking second in density for the United States, has exactly two and a half times the density of population that obtains in Pennsylvania, coupled with only one-sixth the size and less than half the population, undoubtedly accounts for this centralization of responsi-

bility in the smaller State and decentralization in the larger. Pennsylvania has with merit always been strong for general central control by the State leaving inter-community matters to be settled by a home rule policy dependent on cooperation. Under modern conditions this policy may not be entirely sound in the division of waters and in similar matters for it demands increasing voluntary cooperation between many political units without any positive guidance or any assurance that cooperation will ensue.

Conclusion

This review of matters affecting the water supplies of the region today, and the conditions and requirements expected in the future, indicates that fundamentally what problems there are spring from a lack of policy thereto. There is plenty of suitable water available for all future needs and there is no technical obstacle to the accomplishment of any reasonable desire regarding the development or protection of the Region's water resources. These are matters calling for a high degree of understanding and cooperative effort by citizen and municipality alike, in the elimination of pollution, in the evolution of a policy with respect to the best uses of the Region's streams and rivers, and in the attainment of a balance in whatever is done. There is virtue and common sense too in a broad and definite objective such as provided in the act passed in 1928 by the New Jersey Legislature creating the State Water Policy Commission, the preamble to which declared:

"An act to conserve, protect, control, and regulate the use, development, and diversion of surface, sub-surface and percolating waters of the State - - - -".

A similar need in Pennsylvania was recognized by the former Water Supply Commission of Pennsylvania in its Water Resources Inventory Report, Part I., submitted to the Legislature in 1920. In its conclusions, it stated:

"An adequate policy for the control and regulation of the waters of the State can be formulated only insofar as present and probable future conditions are known and understood. Even then it will not be perfected at once, but in many respects must be a matter of

growth, being developed by experience. Yet the State, through its Water Supply Commission, may well undertake a program which will aim at formulating such a policy.

"The necessary conditions are:

First, a thorough knowledge of the streams of the State, so that the problems of control may be known; second, general plans for solving these problems; and third, an orderly legal code, which will make practicable the execution of plans when developed, and will insure control and supervision over constructions affecting the various river systems".

What is applicable and needed for an entire State is even more to be desired for meeting the problems of such a fast growing and populous region as the Tri-State District. There is even need for interstate agreements as already witnessed in the Delaware River Case and the necessity for development within Pennsylvania of the resources of the Brandywine Creek for the future supply of Wilmington.

SECTION II.

SANITATION

GENERAL STATEMENT

The Regional Character of the Problem

The sanitation problem from a regional viewpoint has arisen through a process of evolution. The remarkable growth in size, area and numbers of communities has brought about a concentration and continuity of development in urban areas that make independent solution of sewerage and sewage disposal problems more difficult and often uneconomical. In contrast to this growth, the water courses of the region maintain relatively the same character of volume and flow that they had before the coming of civilization. Thus, there is a limit to their ability to absorb and purify, by natural processes, an ever increasing volume of sewage and industrial waste. Inevitably, the result has been pollution of the waters of these once pure streams.

The effects of stream pollution are quite evidently regional in their scope. The causes, however, are equally extensive, being the result of many local but cumulative conditions. Primarily, then, the solution of the regional sanitation problem lies in the appraisal of these causes and the adoption of means for their greatest practicable reduction.

Relation to Water Supply Sources.-- The use of surface waters for human consumption is the highest purpose to which they can be put or developed. Nature originally endowed this region with a plentiful supply of pure water in every section, but only a few of the important streams remain relatively unpolluted. That it is necessary and desirable to use these surface waters for water supplies is beyond dispute. That they must be used concurrently for other purposes, sometimes in direct conflict with their adaptability as

public water supplies, is not an undisputed and desirable right in the same sense. It is more a point of fact and custom. The question is what can be done to make these customary and established utilizations of our streams progressively less objectionable and dangerous, if they are to continue to be used as water supplies. Because the natural drainage system of the region is such that the discharge of sewage or industrial waste from one community generally affects the water supplies of many others, the necessity for remedying the conditions created is thus a regional one.

One of the best known and outstanding examples of coordinating the various uses of a river is in the Ruhr Valley, Germany. Here the resources of the river are extensively developed to supply water to three and a half million people and at the same time to absorb the sewage from a million and a half people residing on the watershed. The Ruhrverband operates sixty-five treatment works and is now developing storage reservoirs for self-purification of the water and coordinate recreational use. This work is a matter of necessity because there is no alternative.

Relation to Present and Future Use of Watercourses.- Other equally important though less vital uses of our watercourses, likewise affected by their sanitary condition, are concerned with navigation, recreation and the sustenance of fish life.

Navigation is affected seriously by the deposits of silt and decomposing sludge which are contributed by the daily flow of about 400 million gallons of partially or totally untreated sewage into the tidal portion of the Delaware and Schuylkill rivers. Likewise, the odor and chemical constituency of this volume of sewage is such as to be decidedly offensive and destructive to shipping and employees using the port during the summer months.

The recreational use of streams and waterfronts is limited by their sanitary condition. Obviously no park or driveway should follow what is virtually an open sewer. Furthermore, the use of a stream for boating,

bathing, and pleasure fishing will require even higher standards of purity. Increasing concentration of people in suburban areas diminishes the number and availability of streams and waterfronts suitably clean for recreational purposes, while the need for such facilities increases in inverse ratio to the number of those remaining.

The effect of polluted waters on all forms of aquatic life is generally recognized, for past experience has shown that stream pollution has gradually caused the virtual extermination of fish life in the lower reaches of the Delaware and Schuylkill rivers, and has necessitated the moving of the shell fish industry from certain lower sections of the Delaware River where it enters the Bay.

The streams and waterways of the Tri-State District will play an increasingly important part in its future growth and ultimate destiny. Entirely aside from the obvious relation to water supply there is an evident necessity for the gradual improvement of now polluted waters to conditions approaching their original purity. That such a policy must necessarily evolve is supported by the conditions now prevailing in some of our older civilized countries. Germany has restored the Rhine, France the Seine, and England the Thames, from conditions that earlier were a liability to their respective countries.

Source and Presentation of Facts

In the preface of this report have been outlined the sources of factual material used throughout and the manner in which it has been presented. The map depicting the sanitation problem in the region may be found opposite page _____ of the general report and the summary of statistical data in Tables I, VIII and IX, appended hereto.

EXISTING CONDITIONS IN GENERAL

Basic Factors

The fact that 99% of the population in the region resides on land drained by the Delaware River is of particular significance in the sanitation problem. It means that this river must of necessity carry, as its outlet into Delaware Bay, all the liquid waste, treated and untreated, that may be created by the people of this region and others on the drainage area above. The river and its tributaries are thus the final links in the sewerage systems of the entire watershed, which are estimated to serve 3,200,000 or about two-thirds of the 4,750,000 persons residing thereon.

The population distribution, however, varies greatly in numbers and the density with which it occupies the land, bearing no consistent relation to the size of stream or river to which wastes must find their way. The largest cities, nevertheless, are situated on either the Delaware or Schuylkill rivers, but the concentration of peoples at a few points along these rivers results in proportionately large volumes of sewage and industrial waste to be added within relatively short stretches. So far as the region is concerned, their problem is largely one of treatment of these wastes at a few centralized plants.

The smaller communities in the region, particularly the suburban type, have an entirely different set of conditions to face. They embrace generally smaller areas, usually not inclusive of an entire or single drainage area, and for an equal rate of population growth with that in the more densely populated cities they expand more swiftly over undeveloped territory. In comparatively short periods of time sewerage systems must be extended over considerable area, and to add to the burden, the pattern of built-up growth generally stretches indiscriminately over minor ridge and valley without regard to the unity required for a satisfactory sewerage project.

In recent decades, however, a physical knitting together of communities has come about through unprecedented suburban growth. Boundaries of political subdivisions, established without regard for the limits of natural drainage areas, limit the extent of an independent community sewerage project. Local pride and tradition have caused each community to grow, think and act in terms of such artificial limitations. The results have not been altogether satisfactory, as a drainage system, designed to fit within a political subdivision or cover only its developed portion, seldom comprises a single and logically complete unit for the collection and disposal of wastes. Several independent systems usually result on one small drainage area where only one system is physically necessary; unnecessary and costly pumping of sewage may result; and premature and undue financial burdens are placed upon small communities which alone cannot meet them.

The State Departments of Health have recognized one phase of this difficulty and in their regulations for approval of the designs for such systems, require the filing of a general or "comprehensive" plan for the local drainage area, showing what disposition is to be made of that part which lies outside the municipality and which drains through or to it. Such regulations are commendable, but in the absence of enabling legislation for the express purpose of dealing with district sanitation problems, their solution depends now upon the individual initiative of one or more of the communities affected, and the limitations of agreements between them.

Where pollution of the tributary streams of the region exists it is usually from the smaller communities. Due to the smaller volume of flow, the treatment required to eliminate such conditions may have to be more complete than for like communities situated on the larger streams where there is natural purification thru greater dilution.

Sources of Stream Pollution

Domestic sewage and industrial wastes are the two important sources of stream pollution. The load upon the stream may be reduced by treatment of these wastes prior to the discharge into the water.

Domestic Sewage.-- The treatment of sewage may be complete so as to remove not only suspended solids but also to reduce the effluent to a clarified and sterilized state, free from bacteria and putrescible matter. Or it may be the so-called preliminary treatment only; which removes suspended matters but which has little effect upon the effluent as to the removal of the dissolved organic matters or improvement of the bacterial content. The cost of disposal, while depending primarily upon the type of plant and extent of treatment, will be influenced also, both as to cost and effectiveness, by the methods employed in the collection of the sewage and drainage.

The collection system is made up of all sewers from the house to the outfall and may be one of two general types, either the separate or combined system. These two methods of collection for sanitary sewage and storm water are known respectively as the separate system and the combined system. In the separate system two sets of pipes are used, one for domestic or household wastes and the other for storm water or surface drainage. In the combined system the rain water and house sewage are combined and removed through a single system of underground pipes.

The combined system is found generally in the older sections of cities and boroughs, usually having been laid prior to the era when it was necessary to provide for treatment of sewage. The newer systems for the most part are separate.

Where the combined system exists it is impracticable to design treatment works to care for the total volume of storm water mixed with the relative small proportions of sanitary sewage which such a system carries

during rainy weather. Therefore, where treatment is undertaken, the intercepting sewers, which collect the discharge from the individual outfalls and conduct it to the treatment works, are so constructed as to provide for the reception of only the dry weather flow plus a small predetermined quantity of storm water. The major portion of the storm flow is then diverted automatically to a storm drain which discharges directly into the water course.

The type of treatment required in any locality is entirely dependent on the character of use of the particular stream or waterway. The effects can be measured and the treatment be adjusted to give almost any desired result. What is needed, is a definitely recognized and declared public policy concerning the limiting uses of every stream or river in the region. With such a recognition, the proper authorities can put in action and enforce the necessary regulations for every specific case, backed by a known public demand.

Industrial Wastes.- The discharge of industrial wastes into the surface waters of the Region produces an additional problem, quite similar in extent to that of domestic sewage. The effects are much the same on the pollution of streams, and the consequent limitations on their use. The causes vary somewhat, being chiefly dependent on the financial burden which pollution elimination seems to require.

Industrial wastes vary greatly in their composition and concentration. Some have a high organic content and consequently require to be greatly diluted by the natural flow of the stream in order to supply the oxygen needed for purification. Their effects are not much different than those produced by domestic sewage. Others are of a more stable nature, usually chemical, and are especially objectionable because of their odor and taste effects on water supplies. Even dilution fails to eliminate the objections that are raised against this type of industrial waste, so permanent and pervading are their effects. In addition is the pollution

from the anthracite coal mines, in the form of culm and acid mine drainage. The foregoing shows the complexity of the pollution problem and the absolute necessity, if only from a common sense point of view, of eliminating it, even if there were not definite practical and aesthetic reasons for so doing.

Industries must not be forced to close down or move. They are the modern means of livelihood. Yet such pollution cannot go on or increase. Even if it did not affect our water supplies, which it does most vitally, it must cease because of the growing harm to our commerce and even industry itself. Furthermore, the public conscience demands higher standards than in the past for purely aesthetic reasons.

In less than 3 years from the Spring of 1927 and following a policy of cooperation fostered by the Sanitary Water Board of Pennsylvania, industries situated along the Schuylkill River between Reading and Philadelphia have accomplished a reduction in the organic load of 70 per cent, and a lessening of the acid pollution of 60 per cent. These figures apply to 28 major industries causing pollution. The sanitary survey conducted by the Board covered some 660 industrial establishments, only forty of which were "considered of major importance". While doubtless a considerable number of the 660 produce no liquid wastes whatsoever, it is evident that a large proportion, each contributing what might be thought to be a negligible amount, would, as a whole, cause noticeable pollution.

Encouraging as these figures are, the fact remains that the Schuylkill is still objectionably polluted from these sources. Anyone of the million people drinking Philadelphia water coming from the Schuylkill intakes can testify by reasons of the tastes to this fact. The ever increasing long lines of persons, waiting their turn to fill large containers with clear fresh water from numerous springs in Fairmount Park is additional proof, as is also the size of the commercial spring water business.

The Schuylkill and Delaware Rivers

In spite of the more obvious importance of industrial wastes in river pollution, the Sanitary Water Board in Pennsylvania considers that municipal sewage contributes a far more dangerous load to the streams than do the industries. Measured in terms of the depletion of dissolved oxygen, normally contained in clean river water, and in the number of Bacillus Coli present at Philadelphia water intakes, these conclusions are quite evident.

The section of the Delaware River, lying between Camden and Philadelphia is totally depleted of any oxygen content during the summer months, when it is in a putrescent condition. The situation is largely due to the volume of Philadelphia and Camden sewage that is at present discharged raw into the river. On the Schuylkill, the survey of 1928 found a maximum depletion of 30 per cent, from above Reading down to Conshohocken, with one sample taken near the City Limits showing a depletion of 60 per cent.

This method of showing the organic content of river water is exceedingly illuminating to the sanitary engineer seeking its reduction. From the point of view of the water supply operator, however, the most dangerous index is the bacterial load imposed upon the water treatment works. The following are average and maximum monthly average B. Coli loads per 100 C. C. at each of the Philadelphia intakes during 1928.

<u>Delaware River</u>	<u>Average</u>	<u>Max. Monthly Average</u>
Torresdale Intake	20,900 B. Coli	57,000 B. Coli
<u>Schuylkill River</u>		
Roxborough	34,500 " "	64,800 " "
Queen Lane		
Belmont		

These indices may be contrasted with the standards adopted by the U.S. Public Health Service after years of study by its sanitary engineers.

In a public document entitled "Sewage Polluted Surface Waters as a Source of Water Supply" published in 1928, they state - -

"The average well-designed and well-operated rapid sand filtration plant, treating river waters such as are found in the Ohio and other river basins of the Great Middle Western plains is capable of producing with a fair degree of consistency, a final chlorinated effluent of acceptable palatibility and conforming to the revised United States Treasury Department Standard, if the B. Coli index of the raw water does not exceed approximately 5,000 per 100 cubic centimeters".

Present Regulation and Assistance - State Authorities

The sanitary condition of all our streams is receiving far more constructive attention from public authorities than ever before. Though progress has been made, it takes time to eliminate such conditions as existed at the beginning of the past decade. The work that has been begun must be vigorously prosecuted in order that the waste from new increments in population and expansion in industry may be disposed of, necessitating constantly higher standards of treatment if the absorptive power of the stream is not to be over taxed. It is a task which no single public official or body can do alone. Local interests must be subserved to the larger regional problem, with a full understanding of the vital contribution of each unit.

The statutes of the several states applying to Sanitation Problems in the Tri-State District are not only numerous but quite extensive in the powers they grant. Like most laws, they have been built up by a process of accretion and as state wide needs dictated. The evolutionary method has had its advantages in the past, but it would seem possible to fill in the gaps in existing legislation by combining into a single enabling and administrative act the existing laws made for specific situations with new statutes designed for more comprehensive and modern application.

The scope of existing laws under which communities in the Region operate or are regulated is summarized briefly in the following paragraphs.

State of Pennsylvania.-- The administrative code of 1929, (P.L. 177,282) ably summarizes the powers and duties of the State Department of Health, which is the arm of the State Government responsible for the administration and enforcement of the general laws of the Commonwealth applicable to the Sanitation Problem. It designates the Department as the enforcing and investigating agent of the Sanitary Water Board, whose powers and duties are set forth in the same act. Under this act, the Sanitary Water Board is given broad powers for the control and elimination of the discharge of sewage into the waters of the State or into Interstate streams, excepting, however, the discharge of mine and tannery wastes, and the power to study, investigate and make recommendations with regard to the discharge of wastes into the streams.

Commendable and forward looking as is this delegation of power, it means the concentration in a single body of the entire responsibility for the policing and control of sanitation problems as they affect every river, stream, and creek in the State. There is no provision for the setting up of local boards of administration under this General Board, representative of and familiar with conditions in each district. Such boards or commissions elsewhere have proven themselves especially fitted to carry out the policies that may be needed for each local region, in conformity with the minimum requirements of the State policy.

Miscellaneous laws on the statute books convey powers to each municipality, obviously needed for solution of local problems. Municipalities, for instance, may enter into agreements with other municipalities for joint or cooperative action. They may even acquire or condemn, under certain limitations, necessary land, outside their corporate limits, required for sewerage or sewage disposal purposes. Also counties may construct main or trunk sewers and disposal plants with which certain municipalities may connect.

It would seem proper to make such additions to existing laws as will provide for the creation of an initiating authority where joint or combined action is the obvious remedy.

Classification of Streams in Pennsylvania.- After the formation of the Sanitary Water Board in Pennsylvania in 1923, this body set out to classify all streams in the State, according to the following divisions:

- Class A. Clean and relatively pure streams. Class A-1, denotes streams in their natural state unpolluted and uncontaminated; Class A-2, denotes streams nearly in their natural state but subject to minor artificial pollution.
- Class B. Streams in which pollution shall be controlled.
- Class C. Streams which are already so polluted as not to be usable for water supply, or recreational purposes and not capable of supporting fish life.

Though these classifications represent the policy of the Board, no official division of the streams in the Tri-State District has yet been made. It is presumed, however, that inasmuch as Philadelphia has taken water from the Schuylkill above Fairmount Dam since 1801, when the river was in a practically pure state, that this river is assignable to Class B, and furthermore that the use of water by the City of Chester and adjacent territory in the lower Delaware just above its confluence with salt water since 1888 would likewise demand a Class B rating. Though not so announced, it is apparent that the Board has in mind such rating for at least the Schuylkill, for it has summarily notified municipalities adjacent to this river that they must install sewage treatment works, and it is working out, with the manufacturers, methods of treating industrial wastes.

Where existing sources of water supply in the Pennsylvania section of the Region are taken from tributary streams, there seems little reason to believe they should not be assigned a Class A-2 rating, though present conditions on some of them are not up to these ratings. The Neshaminy,

Brandywine and Perkiomen are representative streams in this class.

State of New Jersey.-- Perhaps because New Jersey ranks third in density of population among all the states, and because of the rapidity of its growth, it early appreciated the need for comprehensive laws giving the full powers desired for solution of its sanitation problems.

As early as 1900, the State authorized the formation of a State Sewerage Commission and the creation of sewerage districts and district sewerage boards for the prime purpose of preventing the pollution of its waters. In 1909, the State Board of Health took over the activities of this Commission. The Board now is vested with complete responsibility for the administration of all laws controlling the quality of the potable waters of the State and the necessary works to prevent their pollution. It has jurisdiction over the wastes from industrial establishments as well as those from municipal sewerage systems.

Similar broad powers have been conveyed to the individual municipalities, allowing for joint action between them in the construction, financing and maintenance of sewerage projects. Townships may form sewerage districts and even consolidate and extend them. Although separate legislation has been enacted usually for such purposes, the attitude of the State is typified in a general act passed in 1917 which says, "Two or more municipalities may join together to do any act, maintain any department, or render any service which one municipality is empowered to do, maintain, or render".

Despite the far-sightedness and good intentions of its Legislators, New Jersey has been hampered in the application of these generous laws. There have been questions raised as to the constitutionality of certain provisions, notably the "district" laws. Another drawback has been the reluctance of many of the smaller political units to trust the financing and administration of sewerage and sewage disposal projects to these district commissions, even

though through their agency lies the only permanent and really economic solution.

In response to this desire to create no new, and what was feared might be an inclusive political unit, the Legislature of 1928 authorized the formation of a sewer survey commission for counties of more than 150,000 population, with limited planning and investigation powers only. Such a commission was appointed for Camden County and has recently rendered its first report. Possibilities for using the County as a unit are particularly well adapted in this case.

State of Delaware.- Probably because of the general rural character of the State outside of the City of Wilmington, it was not until 1925 that the jurisdiction of the State Board of Health was extended to control the construction and operation of sewerage systems and disposal works. Earlier, however, in 1915, the fouling of the streams of the state used for drinking water was forbidden and declared a common nuisance.

The activities of the Board of Health have been unusually constructive and helpful to municipalities having sewerage and sewage disposal problems. The small size of the state and the integral character of its populated sections have made this possible. There have been few problems needing cooperative action except in the territory adjacent to Wilmington. The location of most of the populated areas on tidal estuaries has required little attention, so far, to treatment of sewage.

Interstate Agreements.- Pennsylvania has a lead on all the other states in the number of interstate agreements it has signed relative to the subject of stream pollution. It has reciprocal arrangements for its control, and elimination with every bordering state except Delaware, which arises from the fact that the drainage is all towards Delaware. Recently, however, a cooperative study has been undertaken of the sources of pollution in the Brandywine by joint action of the respective Health Departments.

Recognition of the importance of establishing standards of permissible pollution for protection of water supplies in the Delaware River resulted, in 1922, in an agreement between the Health Departments of Pennsylvania and New Jersey. By the terms of this agreement each state undertook to require in its own territory certain degrees of treatment for sewage discharged directly into the Delaware River. The River was divided into three sections, for each of which the standard was different. Briefly described, the conditions required are as follows:

1. NORTHERN STATE LIMITS TO EASTON
Domestic Sewage to be a clarified and oxidized effluent.
Industrial Waste discharge to be prevented so far as legally possible.
2. LINE FROM EASTON TO TRENTON AND MORRISVILLE
Domestic Sewage. Settleable matter to be removed by efficient sedimentation. Additional treatment required where settled sewage would prejudicially affect a water supply. Approval of plans, based on condition that further treatment may be required when deemed necessary.
Industrial Wastes discharge, when untreated, to be restricted if a menace to health, or nuisance to either sight or smell.
3. TIDAL PORTION: Line from Trenton to below Philadelphia and Camden.
Domestic Sewage. Effluent to be discharged into deep water after sedimentation. Additional treatment required where settled sewage would prejudicially affect a water supply. Approval of plans based on condition that further treatment may be required when deemed necessary. Limit of two miles above or below a water intake, for discharge of only settled sewage, deemed prejudicial to water supply.

It is to be noted that the agreement did not apply to the tributaries of the Delaware, this phase being left entirely to the separate jurisdiction of each State. The settlement on this uniform policy, however, for limiting pollution of the interstate waters of the Delaware River is a milestone of progress. It has resulted principally in the building of the sewage treatment

plant at Trenton and initial units at Camden and in hastening completion of the Philadelphia program, which eventually will provide sedimentation treatment for all the city's sewage in 3 huge plants. Pending completion of the latter, the Delaware in the vicinity of Philadelphia remains in a grossly polluted condition.

EXISTING CONDITIONS IN PARTICULAR

Although the designation of district boundaries for the intensive study or solution of sanitation problems is not the purpose of this report, nevertheless, the region has been divided into seven convenient districts for the logical presentation of the conditions in each section, as follows:

1. The area draining through Philadelphia
2. Delaware County drainages
3. The Schuylkill Valley above Philadelphia
4. Camden County streams and adjacent territory
5. The Trenton- Mercer County territory
6. Wilmington - Brandywine Creek Valley
7. Miscellaneous Outlying Sections

The Area Draining Through Philadelphia

The local territory draining to or through Philadelphia contains not only the most densely populated areas in the Region, but over 60 per cent of the regional population. It includes the entire 81,920 acres lying within the city, and about 56 per cent additional territory of suburban character lying immediately adjacent to the city and recently undergoing very large population increases.

As an outcome of the 1905 Purity of Waters Act, the City of Philadelphia was directed to prepare a comprehensive plan for the collection and proper disposal of its sewage. In 1914, after almost a decade of painstaking surveys, research and study, a report was prepared and presented to the State

authorities outlining a Comprehensive Plan for the Collection and Treatment of Philadelphia Sewage. The plan embraced all the territory then sewered or to be sewered in the immediate future within the city limits, and in addition provision was made in the proposed designs for both the collecting system and treatment works, for the reception of sewage from _____ acres lying outside of the city. Subsequently provision was made for draining _____ additional acres.

Upon acceptance of this plan in 1915 by the Department of Health of Pennsylvania, the city was required to embark on an extensive construction program designed to concentrate all sewage at three separate points along the Delaware waterfront where treatment works were to be constructed for its disposal. Locations for these works were chosen as follows: Northeast Works at W heatsheaf Lane and Delaware River; Southeast Works at Packer and Swanson Avenues; and Southwest Works between Penrose Avenue and Island Road. All new construction as well as reconstruction of the sewerage system was to be done in conformity with this plan. Due to delays incident to the war and its aftermath, steady intensive work under this program did not get under way until 1923, at which time a supplemental agreement was entered into between the State Department of Health and the City, in which the City was obligated to spend a minimum of \$3,000,000 annually toward the works needed to put this plan into effect.

The report stressed the need of completing the program in the northeast section of the City for protection of the water supply as a prior operation over all other sections. The first units of the Northeast Sewage Treatment Works, designed to treat 60 million gallons of sewage per day, have been constructed and were placed in operation October 29, 1923. This capacity is approximately that which will be needed to serve the present population when the entire collecting system for the district served by this plant has

been completed. No work has been done on the Southeast Treatment structures, although the outfall conduit to the River has been completed, and the necessary property has been acquired. At the Southwest Works, construction has started upon both the main intake conduit and outfall conduit to the River. The local sewer intakes have been completed and the sewage lifting station has been completed and in operation since September 1, 1927.

A further large expenditure of time and money will be required to build the necessary intercepting and collecting sewers to bring sewage which now discharges directly into the Delaware River and the Schuylkill River below the Fairmount Dam, to these plant locations, although work is now proceeding upon the Schuylkill River intercepting conduits. The Tacony Creek interceptor, and the Upper Delaware collector, and recently the Frankford Creek interceptors, have been completed and connected to the Northeast Works.

Even this notable, expensive, and time-taking progress has resulted in no decrease in the pollution of waters adjacent to Philadelphia, which can be marked by observation. The Schuylkill River below the Fairmount Dam is equivalent to a large septic tank for the digestion of the sewage from over one million people, with the resulting odor during warm weather. It approaches a condition of nuisance to everyone using the westerly approaches to the central city. The conditions are aggravated by the fact that during the dry months the city is using practically the entire flow of the Schuylkill River above the dam for water supply purposes, thus eliminating such cleansing action as the river itself might contribute.

The Delaware River from the northeast works to well below the city is in a seriously polluted condition during the same periods. Sewage from the central and south portion of the city is disgorged at almost every intersecting street. The resultant conditions were the subject of an extensive survey inaugurated by the Board of Trade in the fall of 1929 revealing specifi

complaint by 15 important business and shipping interests and are a distinct liability to the business of the port.

Other grossly polluted waters in or adjacent to Philadelphia are Frankford Creek and Cobbs Creek below 75th Street. These streams are receiving a very large amount of untreated sewage and industrial waste, but the immediate placing in service of the Frankford Creek interceptors should relieve this location. The conduits have been completed for the diversion of Philadelphia sewage from Cobbs Creek and will shortly be put into service.

Increased costs have meant less material progress than was expected when the original estimates were made. A total of \$23,000,000 has been spent or authorized since the approval of the original plans and, to complete the entire project, it is evident that the additional expenditure must exceed what has been spent to date. In the first stages of such an immense undertaking, most of the time, money and effort have, of necessity, been directed toward the construction of the collecting system and other structures necessary to concentrate at the three treatment work sites the sewage from the entire city. It is thus that material progress, as measured by the amount of sewage treated, is apparently small in comparison with the money expended and the time consumed. Shortly, the results of this steady progress will become more apparent.

The incentive for pressing the work on the Northeast section has been, of course, the necessity for protecting the water intake at Torresdale from pollution by the city's untreated sewage carried there by the flood tide. The location of the Northeast Works places the discharge point of its effluent 5-1/2 miles downstream from the water supply intake. Repeated and numerous experiments with floats as well as bacteriological tests during flood tide have shown that this tide may carry the Northeast Works' effluent upstream over 7 miles, although this condition is not normal continuously. The

treatment process now practiced is of the sedimentation type, only, with the result that the bacterial content of the effluent is not materially different from that of the raw sewage before it enters the plant. The treatment processes will be further refined to reduce this bacterial content to an amount within the oxydizing power of the river to assimilate.

Provisions in the 1914 Plan for receiving sewage from territory outside the City have enabled an agreement to be promulgated with Cheltenham Township, whose sewage enters the city by way of a trunk sewer along Tacony Creek. In the design of this latter sewer within the city, provision was made for the flow from the township, and the agreement provides for an annual depreciation charge on the extra cost of this construction to care for the conveyance of sewage from the township. The township pays in addition a further proportional annual depreciation charge on part of the capital investment in the Northeast Treatment Works; their proportion being determined by the ratio of the Cheltenham Township flow to the total flow. They also pay similarly for the same proportion of operation and maintenance cost. This agreement, made in 1923, seems to be quite equitable to both parties. The present annual cost to the township is somewhat over \$6,000.

In 1902, a City Ordinance provided for the conveyance of an undetermined amount of sewage from Lower Merion Township, the cost to the township being \$100.00 per annum. This agreement was undoubtedly instigated by the necessity for protecting the Philadelphia water intakes along the Schuylkill River, from pollution by the sewage from the township that would naturally drain to the Schuylkill above these intakes. The township has established 5 pumping stations, raising this sewage to those sections of the township drained by the east and west branches of Indian Creek, or other lesser drainages, which normally flow by gravity into the city system. As a result, the city is now receiving sewage from 25,000 population at some seven different

points. This sewage for the most part flows into existing combined sewers within the city which at the present time discharge directly into either the Schuylkill below Fairmount Dam or to the Cobbs Creek interceptor discharging untreated sewage below 75th Street. The 1902 agreement provided for the signing of a new agreement upon the completion and connection of necessary intercepting sewers and treatment works by the city. The 1914 plan recognized the necessity for such provision in the design of the city collective and disposal system. It is evident, however, that an agreement similar to that made with Cheltenham Township will be required when this stage is reached and that such a new agreement will be far more costly to the township than the present one of \$100.00 per year. Furthermore the township will have to bear their own cost of pumping an amount greater than the present 1,700,000 gallons of sewage per day.

Delaware County Drainages *

The natural contour of the territory comprising Delaware County makes it a distinct unit for the consideration of its sewerage facilities. Its most important streams rise just north and west of the boundary adjacent to Chester County and flow southeasterly and south into the Delaware River. Most of the population is situated on the lower part of each drainage area, yet despite this natural advantage, the sewerage and sewage disposal problems are exceedingly complicated.

There are, all told, 25 independent boroughs and 9 first class townships in this county in addition to the City of Chester. Each political unit has found it difficult to solve its sewage problems by itself, although the county is drained by only 7 important streams. These are Cobbs, Darby, Crum, Ridley, Chester, Marcus Hook and Naaman's creeks.

Realizing the opportunities such a natural drainage system offered to the communities in the county for coordinate or combined sewage collection

* This section is to be brought up to date after consultation with Mr. Damon.

and disposal, there was instituted, several years ago, a movement to draw up a plan for the comprehensive collection and treatment of sewage. The working out of the engineering, financial and political details of such a project was entrusted to an unofficial commission, made up of outstanding men representing all of these interests. The plan which they subsequently inaugurated may well be called the Damon-Snow-Stevenson Plan, as these men have been the prime movers in pressing the natural opportunities before the various municipalities.

The plan in its preliminary form suggests the building of intercepting or trunk sewers for the principal creeks in the county, leading to sewage treatment plants located at strategic points along or near where these various creeks empty into the Delaware.

There will accrue tremendous benefits to the entire county when and if such a coordinated enterprise is undertaken.

Financially, the advantages are similar to those which would be experienced by any public utility enabled to enlarge its field of activity and operate over the greatest possible economic territory. Experience has shown that one electric system, for instance, can operate in numerous contiguous communities far better than if individual systems are set up for each community. Under the Delaware County Plan, communities may have a somewhat higher first cost, but they will be assured that present day expenditures are being made along sound financial lines, not subject to inevitable changes if only adapted to the needs of the moment.

The advantage to the value of real estate, where there is assurance that not only the present but the future sewerage requirements of the entire area of any community have been taken care of under a carefully worked out and comprehensive plan, needs no explanation.

From the planning point of view, perhaps the most important contribution that such a plan will make will be the opportunities it will offer for

the development of the county's natural recreational features, which will in turn greatly enhance property values. The Regional Plan has included in its proposals the development of many of the beautiful creek valleys for which Delaware County is so famous. It is highly doubtful whether such plans could be carried out if these creek valleys were lined with a sewage outfall and treatment plant for each of its many adjacent communities. Furthermore, there are distinct opportunities for obtaining the necessary land at the bottom of these creek valleys, unsuitable for building purposes, at the time the easements are procured for the building of trunk sewers. This practice is quite common in some localities, the most outstanding example in the Region being along the Wissahickon and Tacony creek parks in Philadelphia. The Westchester County Park System was first initiated because the pollution entering the Bronx River completely ruined the value of the adjacent land. By buying this land and installing the necessary sewerage facilities, the county was able to reclaim it for public use. Delaware County need not let the situation reach the inevitable, but may well seize the opportunity today.

The Damon-Stevenson-Snow Plan as so far developed does not provide for the sewerage of territory in the upper part of the county, where the population is still quite rural. Much of this area lies on the watersheds of the Crum Creek and Ridley Creek water supplies. The time is not far off, perhaps in the next decade, when definite sanitary provisions will have to be made for the protection of these streams. The two obvious alternatives are either the taking over of a large portion of these drainage areas as public reservations to provide definite sanitary control, or else the building of a costly sewerage system conveying all sewage to points below the intakes for water supply.

The plan as proposed is indeed comprehensive. It combines the sewerage and sewage disposal problems of over 30 political units, in providing for the sewerage of 65 of the 185 square miles of the county. The balance of

the territory is composed of the City of Chester and the Borough of Upland, which have their own systems, and the westerly portions of Delaware County, comprising about 115 square miles, which at the present are relatively undeveloped. Sixty-two per cent of the present population of the county lies within the territory covered by this project. By 1980 the proponents of the plan expect that the population of this same portion will reach 630,000 and that the sections unprovided for will have less than 90,000.

This first extensive attempt for the unofficial incorporation of district sewerage problems is most noteworthy. It is well, however, to observe the methods used in some of the counties in the middle west, and even in the Boston and North Jersey metropolitan areas, for the solution of similar problems. These are described in the concluding part of this report.

The Schuylkill Valley above Philadelphia

The territory lying within the Schuylkill watershed and situated above the boundaries of the City of Philadelphia, has a population of 450,000 people, and a density of 250 per square mile. It is a highly industrialized area, ranging from extensive coal mining operations situated in the Upper Valley to such large water users as paper mills, iron and steel works, and textile industries, etc. The water supplies for Pottstown, Royersford, Spring City, Phoenixville, Norristown and Bridgeport are obtained from the main stem of the river, and most of the industries are also located along the river.

Since 1929, sewage treatment works have been placed in operation at Bridgeport and Conshohocken while construction work has been started on works for Norristown and Pottstown. Plans have been prepared by Royersford and Spring City, and are in process of preparation for Phoenixville and Birdsboro for the construction of treatment works. The large State institution at Pennhurst is preparing to construct complete treatment works during this biennium. Thus, in the short space of five years - communities with a population

of _____ previously discharging raw sewage into the river, have initiated or will have completed a program of preliminary treatment of domestic sewage and much of the trade wastes above the City of Philadelphia.

As long as Philadelphia continues to use, as it does now, practically the entire low water flow of the Schuylkill River for its water supply, it will be desirable to progressively reduce the volume and character of the polluting wastes that now enter it. Even should the city decide to abandon the Schuylkill as a source of supply at some future date, it is quite probable that the growth of population and industry between Philadelphia and Reading will have reached a point that would dictate equal standards of purity for its own use. It is certain that the industries of this prosperous and populous valley depend very largely for their success on having an economic and pure water supply. It is a financial advantage for these communities to continue to use the Schuylkill for both their domestic and industrial supply rather than to develop individually upland sources which, in proximity to Philadelphia, are more needed for the city itself and its immediate suburban area.

It is to be hoped that the agreements promulgated with the mining interests in other parts of the state, where the dumping of acid mine wastes, of the Clarion River Basin, is to be abandoned where it enters streams used for water supply, may be the forerunners of similar agreements in this territory, particularly with reference to the discharge of coal mine silt. The Reading Chamber of Commerce has been active in investigating the economic possibilities of reclaiming the coal silt before it enters some of the tributaries of the Schuylkill. Further research is needed to make such reclamation an economic operation for the running companies, for very little argument is needed to demonstrate the value of such reclamation to downstream communities. In the meantime, Philadelphia continues to dredge deposits in the navigable

portion of the Schuylkill channel, and, above the Fairmount Dam, the beauty and usefulness of the Pool is being destroyed by the accretions of culm and silt. Obviously, the real value of the marked reduction in organic and chemical pollution, recently attained, will not accrue until an adequate solution is found for ridding the river waters of coal silt.

The further industrialization of the Schuylkill Valley will bring into closer relationship communities now solving independently the more urgent problem of sanitation. The virtue of any plan formulated for the remaining present problem of silt pollution, lies in its ability to coordinate the needs and action of the whole Schuylkill Valley under comprehensive management, to the end that future industrial development will go hand in hand with better and more attractive conditions for accomodating the increase in population.

The derivation of "Schuylkill" shows that it was the Dutch name for "Hidden River". It is certain that the charm of its winding deep valley offers splendid opportunities for the recreational development of its banks. As the industrialized population of this valley grows, the need for such development will become more evident than it is today. This, together with its use for municipal and industrial water supplies, makes its reclamation more desirable than its reversion to a channel for untreated wastes. A clean Schuylkill means prosperity, health and happiness for the whole valley.

In respect to the amount and distribution of its population and the number of independent political units involved, sanitation problems in this area are similar to those in Delaware County. Due, however, to a much flatter terrain, the measures already adopted to mitigate stream pollution have been nullified in part by the action of the tides in conveying the heavily polluted waters of the Delaware River as much as 5-1/2 miles inland. Comprehensive plans for the solution of the Camden County problem were recommended by the official Camden County Sewerage Survey Commission in September, 1930.

The built-up portion of this county and adjacent portions of Burlington and Gloucester counties are drained almost entirely by the following streams: Pensauken Creek, Cooper River, Newton, Big Timber and Woodbury creeks. Their sources lie about 12 miles back from the Delaware River, the territory beyond draining easterly to the Atlantic Ocean. In Camden County, 91% of the population is within 10 miles of Camden City Hall, and the indications are that soon the entire middle and lower portions of these drainage areas will be largely built-up. It seems logical, therefore, to think of sewerage and sewage disposal problems for these sections as integral with each drainage area irrespective of political boundaries.

The excellently presented report of the Camden County Sewer Survey Commission merits the careful consideration of every community in this area. It has not minced the facts. Out of 22 sewage treatment works serving 17 municipalities, 9 are not effective, 73% of the 22,000,000 gallons of raw sewage and industrial waste is untreated, most of this coming from Camden, where work is underway for eventual treatment of all the cities' sewage. Float tests showed that the septic condition of the Camden waterfront and tidal sections of tributaries was due to sewage originating on the New Jersey side and entirely independent of similar conditions on the Philadelphia waterfront. One-third of the dry weather flow in the Cooper River is sewage, in addition to that conveyed upstream by the tides, and in Newton Creek similar conditions prevail near its mouth.

This commission has recommended: that trunk sewers for Cooper and Newton creeks be provided as population increases warrant, and that for the present a trunk sewer around Newton Lake is necessary; that certain disposal plants be revamped to more adequately treat sewage; that expert supervision by a biologist and engineer be provided by the County for all treatment works; that dams be constructed across Cooper River and Newton Creek at the head of

navigation to eliminate pollution carried by flood tides; and that legislation be enacted for the creation of a permanent Camden County Sewage Commission to cooperate with the State Department of Health in matters pertaining to the collection and treatment of sewage and the more efficient operation of disposal works.

Outside of Camden and Gloucester, and the effects of their sewage, the present problem has grown out of the rapid expansion of population and the number of small political units created in the last 20 years, each of which has independently constructed its own sewerage system and disposal works. The problem is one of revamping many individual enterprises to conform to a coordinated scheme for the separate drainage areas. There is only one example of joint action, that of the Merchantville-Pensauken Sewer and Water Commission.

Aside from considerations of health and the necessity of eliminating nuisances, one of the strongest arguments for reclamation of streams in this area is for the purpose of developing their recreational values. The work already done by the County Park Commission on the Cooper River Parkway and that proposed for Newton Creek, requires a clean and attractive stream if it is to be enjoyed by the public.

Trenton-Mercer County Territory

The rapid growth of the suburban sections outside of the City of Trenton has created in the last few years a sewerage and treatment problem of growing magnitude. Practically all of the territory north of Assanpink Creek drains away from the city boundary, so that no provision for extension of the city system was made at the time it was designed by Rudolph Hering in the early 80's and 90's. South of this creek several of the communities are detached with open, partly developed areas between them and the City. The drainage is into small runs which discharge into Assanpink Creek just before

it enters the city. Elimination of pollution in Assanpink Creek is, therefore, the concern of the city, though caused by outside communities. A commission is now studying this situation.

Acting in accordance with the provisions of the Inter-State Agreement of 1922, providing for preliminary treatment of all sewage entering the Delaware River below Trenton, the city has constructed preliminary sedimentation treatment works, whereby all its sewage passes through this plant. It has been the desire of those communities lying close to Trenton to tie in their own local system with the Trenton treatment plant. This, as pointed out for northern suburban sections, would be highly impractical, and would necessitate the reconstruction of many of the large trunk sewers within the city. Furthermore, due to the contour of the land, many of these communities would have to install pumping stations to raise their sewage over the watershed.

The situation is one that will doubtless clear itself up as these communities grow larger and become further built-up. At the present stage it is difficult for them to finance and construct sewerage works. They would rather temporize and connect with the city system. Present conditions are further augmented because the City of Trenton has extended its water mains into outlying territory, further increasing the need and desire for sewage facilities. Such practice, however, has been curtailed recently because of this very fact. One of the reasons for annexation agitation is doubtless due to the need for both modern water and sewerage service.

It would seem that one solution might be in the formation of a suburban sewerage district, embracing territory developing most rapidly and lying entirely within the Shabakunk watershed, by which it would be possible to construct and finance by long term bonds, a comprehensive sewerage and disposal system. The sections south of Assanpink Creek could be handled similarly, and perhaps jointly.

The section of the county not draining to the Delaware but lying within the Raritan drainage basin, has already seen the need for such coordinated action. At Princeton there are in existence 4 distinct disposal plants - one for the college, two for the municipality and one for the township. Plans have been drawn up for combining these four small districts into one district and treating the sewage at one large plant. This plant is to be located on the Millstone River below the lake, eliminating all of its present pollution and where it will care for new areas that will develop in the future.

Wilmington-Brandywine Creek Valley

The northern part of the State of Delaware, comprising part of New Castle County, is drained by the Brandywine Creek and Christiana River with its main tributaries, White Clay and Red Clay creeks. All of these streams rise within the State of Pennsylvania, where lies the largest part of their watershed area. The City of Wilmington is between the Brandywine and the Christiana at their junction and confluence with the salt water portion of the Delaware River.

For the outlying territory within the State of Delaware there is no outstanding district sanitation problem. The City of Wilmington is sewered by a combined system discharging into tidal salt water at several divergent points where there is a moderately adequate dilution. The other large communities, such as Newark, Newport, and New Castle, are installing or have under way modern sewerage and sewage disposal facilities. Wilmington is empowered to extend its sewers into adjacent territory as the need arises. In 1928 the Legislature gave New Castle County the authority to construct sewerage systems in unincorporated areas, the Act being passed to solve the difficulties in the Richardson Park-Marshallton suburban areas. The recently appointed Regional Plan Commission is authorized to study the situation in the entire county and prepare a Master Plan for guidance of future expansion.

There can be little doubt that as Wilmington grows and extends its sewerage system into tributary suburban territory there will arise the necessity for preliminary treatment of sewage. The development of the port and use of sections of the waterfront for recreational purposes will make a clean harbor desirable. Ground might now be purchased and held in reserve for such an eventuality.

The most critical sanitation problem in this area is concerned with the pollution of the Brandywine Creek, the source of Wilmington's water supply. A sanitary survey is now under way to determine the source and degree of this pollution, most of which is believed to come from communities in Pennsylvania. Upon completion of this survey, there should be an agreement entered into between the two states setting up mutually satisfactory standards of treatment for both domestic and industrial sewage now discharged into this creek.

Miscellaneous Outlying Sections

Elsewhere in the Region there are isolated cases of more or less regional importance. Most of them are sanitation problems which are acute because of the situation of a community near the source of one of the important streams of the region. Such a situation requires a high degree of treatment because of a lack of any helpful dilution. Communities like Lansdale, North Wales, Doylestown, Newtown, Malvern, West Chester and others are in this class. Most of them discharge into streams later used for Water Supply. In every case there is need for broader appreciation of the relation of the local problem and its responsibilities to the region.

Coatesville, South Coatesville and Modena have a splendid opportunity for the planning of a comprehensive system of collection and disposal of sewage looking forward to the time when the existing systems and disposal works may be combined into one cooperative or joint unit. Despite the

evidence of the last census, these communities are going to expand more rapidly in the future and the extension of facilities now under consideration should look forward to this eventuality.

Another small detached group of communities which might consider joint enterprise is composed of the boroughs of Langhorne, Langhorne Manor, South Langhorne and Hulmeville. Their strategic situation on the Lincoln Highway and midway between Philadelphia and Trenton means certain expansion. Financially they will find advantage in a joint enterprise.

CONDITIONS TO BE MET IN THE FUTURE

Population Growth

Future sanitation problems, as with other physical public facilities, depend in the first instance on the population growth and its expected distribution. The curve of urban population in the past indicates that by 1980, 85% of the total population, or 5,485,000 people, will be living in urban areas as against 2,928,000 today, which is an increase of 2,557,000 or 87%. Sewerage facilities will be required most certainly by these additional urban inhabitants, just as today, and furthermore practically 100% of the sewage from urban communities will be treated as against only about ____% at the present time. Plans for the treatment of sewage must therefore provide for much of the growth of the past as well as that expected in the future.

Although the completion of sewage treatment works for Philadelphia, Camden, and Chester will greatly increase the population whose sewage is treated, the fact that the last decade showed 72% of the population growth taking place outside of the 5 principal cities, indicates where some of the most urgent and difficult sanitation problems will be. The fast growing suburban areas comprise many units and spread over a wide expanse of territory. The closing of gaps between these communities will present opportunities and necessities for inter-community enterprise. Land becomes "built up" when

the density approaches 4 or 5 persons per acre and the population is rather evenly distributed. Such conditions make practical the design and construction of sewerage works for the whole drainage area, independently of local boundaries.

Development of Stream Valleys

The filling in process of suburban growth, whereby open lands heretofore available for recreation and scenic enjoyment, are being rapidly diminished, necessitates the preservation of areas both accessible and desirable for public recreation. Such opportunities are to be found in the stream valleys of the region, especially in the urban sections where usually this land is undesirable for building purposes. Development of stream valleys often requires inter-community action and the feasibility of their use for recreation depends on their sanitary condition. Such use introduces another important element, requiring coordination of enterprise as well as of communities.

Conclusion

There is unquestionably an insistent and growing demand for redemption of many of the region's streams to a clean and sanitary condition and the adoption of measures to protect those remaining unspoiled. Their clean condition is recognized as an asset and necessity for many reasons. Water supply investments will be conserved and suitable future supplies assured, recreational use will be possible, and the value of adjacent property enhanced. The cost is small in comparison with the returns that will accrue in both tangible and intangible values. The efforts of public health authorities to this end, merit continued and increasing public support by leading citizens and a further broadening of cooperative powers.

The provisions in the regional plan for extensive open space reservations in stream and river valley throughout the region are based on a use

and a condition of the water which will be commensurate with the development proposed. The extensive influence of the region's water-courses, however, requires the evolution of a public policy with regard to the desired purity of every stream so that these plans may merit consummation. Their carrying out will set the standard for the present and future and awaken the imagination of every citizen.

SECTION III

THE COMBINED PROBLEMS, METHODS OF SOLUTION & CONCLUSIONS

SUMMARY

General Statement of the Problem

The principal purpose of the preceding sections of this report has been to emphasize the extensive character of many of the water supply and sanitation problems in the Tri-State District. Although present day individual water and sewerage problems are simple and concrete in the abstract, there are, nevertheless, elements in their satisfactory solution that extend beyond the boundaries of the municipalities immediately concerned. Of even greater regional importance are the plans that must be made and carried out, for providing future generations with an adequate and pure supply of water, as well as the proper and efficient disposal of water-borne wastes. Furthermore, it is evident that neither water nor sewerage problems can be solved by themselves without a prescribed knowledge of the effect or influence of each separate group of problems on the other.

Public authorities in seeking a remedy for present conditions and a flexible future solution, have an additional and altogether equally important consideration to bear in mind. The location of the surface water sources for public water supplies in the Region and the methods used for the disposal of sewage and industrial wastes have an intimate bearing on other plans being made for all public improvements and the orderly and economic development of the Tri-State Region.

While the use of the surface streams and rivers of the Region for domestic water supply is undoubtedly the highest use to which they can be put, it is, nevertheless, paramount that their development be attacked from a broader point of view. The logical adaptability of these river and creek valleys

for recreation, industry, and urban habitation is a compromising utilization which should receive fuller consideration than in the past. Greater understanding of the growth and distribution of population in the Region, and its needs as a regional organism, is essential to a sound program for solution of water and sewage problems.

Outstanding Facts Brought Out in This Report

A brief resume of some of the important facts bearing on the water and sanitation situation follows.

The population of the Region in the past 50 years has grown from less than one and a half to over three and a half millions representing an increase of 143 per cent. Previous to 1910, the major portion of this growth took place within the central cities of the Region. From 1930 to 1980 there is every indication that the population will increase by an increment of 2,944,000 to 6,466,000 or over 83 per cent. The most rapid rate of growth will take place outside of the central cities, in areas that are now called "suburban", for the results of the 1930 census have shown that in the past decade 72 per cent of the 10 year increase came in areas outside of the cities of Philadelphia, Camden, Trenton, Chester and Wilmington.

This region is endowed with plentiful water resources, lying as it does almost entirely within the great Lower Basin of the Delaware River. The resources of the Delaware and its tributaries were early recognized as an important factor in determining the location of the early settlements and their subsequent growth.

Statistics show that this region uses 467 million gallons of water on the average every day in the year. Of this 92 per cent comes from surface streams and rivers, and all from points located within the Region. Philadelphia is the greatest single user, consuming 77 per cent of the total amount. The balance is supplied by 96 systems widely distributed and using a great variety

of sources ranging from underground wells and the smallest creeks up to the Delaware River. The Delaware and Schuylkill Rivers, however, supply 92 per cent of the surface water used. The potential future increase in water consumption will be largely on the established systems.

The use of water in the Region is expected to amount to 787.5 million gallons per day by the year 1980, on the assumption that there will be economies in the present per capita use of water and an increase in the percent of the total population served during the next fifty year period.

The spread of population throughout the Region, particularly along the valleys of the principal rivers and streams, has produced great quantities of water borne wastes which find the water courses as the only channel for their disposal. These water courses, earlier quite adaptable as water supplies, have become seriously polluted as population expanded, sewerage systems were installed, and industries grew. There has thus evolved the practice for communities to pass on to others lower down, the pollution of partially treated or even totally untreated wastes, the only redeeming feature being a certain limited ability of the river or stream to purify itself.

While modern engineering science has been able to furnish a safe supply of water from such sources, there are grave questions as to the desirability of continuing this practice because of aesthetic and other reasons. It is evident, in spite of the commendable efforts of state health authorities toward the elimination of gross pollution, that the increasing turnover of water as the prime element in waste disposal renders the surface waters of the larger streams less desirable as sources of water supply.

The expansion of suburban and heretofore detached communities surrounding the large cities of the Region is rapidly filling in the gaps between these small and independent units. Problems of sewerage, and sewage disposal especially, once relatively isolated, are now closely interlocked with those of

other communities situated on the same or adjacent drainage areas.

Application of These Facts to the Problem

The foregoing statements indicate primarily that there is now needed a more aggressive and positive policy regarding the use and treatment of the Region's water resources and more of cooperative or joint effort in consummating the desired ends. The situation has accelerated to its present magnitude because methods for meeting the problems incident to the growth of the last twenty years have not kept pace with the new conditions. Though technical skill has advanced to a great degree, there is lacking the adequate means and coordination through which this skill may be fully exercised to solve problems of such fundamentally extensive and often regional nature. The growth of urban and suburban units, in close proximity to each other, demands greater freedom for solution of such problems, than is possible under a strict interpretation and limitation of these individual community boundaries. Even for groups of contiguous communities there is need for some expression, as parts of larger economic and physical areas, for which there is now no legally recognized body to which common problems of water supply and sewage can be referred for coordinate planning and active administration.

The development of the planning idea for such extensive areas as a region of some 4,500 square miles, and involving territory in three states, is clearly applicable to such facilities as the highways, pleasure ways, and the transportation systems of the area. It is felt that there is equal need for approaching the water and sanitation situation with the same planning forethought even though the method for carrying out such plan or plans may have to be integrated into simpler units. The usefulness of a comprehensive general plan is apparent. To this end, a water policy for the present and future by each community should be coordinated with a policy for this region, which in turn would be correlated with State policies.

The growth of the United States has taken place under a rigid system of governmental units, not designed for recognition of any integral area between its simplest subdivision and the county, or the county and the state. The success of metropolitan and even regional utility services under private ownership has been due largely to the fact that they were able to set up natural areas and a unified organization for this extensive service. When it comes to such public functions as water and sewerage service, it is equally desirable to PLAN their functioning at least over as wide an area as is technically and economically desirable. It may be wise to continue a policy of home rule and not create super units for political or taxation control, but having once established a plan, the steps that naturally follow for its execution can be adapted to the needs and composition of the human and governmental factors involved.

With the knowledge that there are various methods for working out a comprehensive water and sewerage plan in the Tri-State Region, and obtaining its progressive execution, there have been briefly summarized herewith, some of the ways and means found adaptable elsewhere. These examples are cited as typical methods in use to solve extensive water supply and sewerage problems. It is not intended to convey the thought that any one would be applicable in the Tri-State Region, but rather to show examples and emphasize the possibilities in setting up more comprehensive means than now exist in the Region.

METHODS FOR PLANNING AND EXECUTION OF COMPREHENSIVE PROJECTS

Existing Methods and Their Limitations

Attention has been drawn in this report to the methods now in use, and available under the law in certain jurisdictions, for securing unity of action between small groups of communities in the Region. For certain cases these are wholly adequate and satisfactory for the solution of the intercommunity problems. They may be summarized under the following headings:

1. Extension of municipal jurisdiction.
2. Contracts between municipalities.
3. County administration.
4. Private enterprise.

In order to emphasize the possibilities for planning and administering cooperative enterprises in the Tri-State Region under these methods and their limitations, there is submitted, herewith, a brief statement concerning each.

Extension of Municipal Jurisdiction. - The fact that water and sewerage projects generally entail considerable cost, especially when extended as an after-thought beyond municipal boundaries, means that this method has not been popular for the communities surrounding a large city. Oftentimes the city finds it necessary to charge rates in excess of those for its own citizens, this being generally so for water service.

Usually extramunicipal powers are used for general planning purposes, rather than for direct construction involving costs over which the outside community would have no control. Any control of the smaller by the larger municipality is likely to be resented.

The requirement of the Departments of Health, that a comprehensive plan be submitted involving the balance of the local drainage area within which a community lies, is an example of what can be done by extending municipal jurisdiction. Here again, however, the powers are limited to planning only, the outside municipalities being left to work out their own detailed solution in conformity with the comprehensive plan, and without financial aid.

Contracts Between Municipalities. - The method of furthering coordinated enterprises by contract between the municipalities concerned is exceedingly popular in the Tri-State Region. Laws have been enacted from time to time, as previously outlined in this report, enabling municipalities to enter

into agreements for coordinate water, sewerage and sewage disposal projects. When, however, the type of desirable project is so extensive as to involve, for example, more than two or three communities, the contractual relations may be exceedingly involved. Municipalities are generally unwilling to leave the operative control of such services in the hands of one of their members.

Examples in the Tri-State Region of successfully handled cooperative enterprises by this method are to be found in the contracts between the City of Philadelphia and Cheltenham Township; between the City and the Philadelphia Suburban Water Company; in the organization of the Merchantville-Pensauken Water and Sewage Commission; and numerous others. There are apparently adequate laws for this type of solution, but the method is slow, unwieldy and not always effective in promoting a feeling of community cooperation.

County Administration.-- Resorting to the county as a unit for the handling of sewerage problems particularly has the advantage that the county generally spreads over enough territory to make such enterprises under its jurisdiction entirely feasible. Furthermore, the required machinery both for administration and taxation already has been set up.

This latter statement is found to be more true in the middle west, where the county is a far stronger unit than in the east. There, enabling acts specifically designate the county as a sewer and even a water district. Where certain sections of the county are more built-up than other sections, and consequently the service needed is not evenly distributed throughout the county, provision is made for establishing special taxing districts, conforming to natural drainage areas. Where the municipalities are able to care for their own local sewerage systems the county builds only the main intercepting sewers and the required disposal plants.

In Cuyahoga County, surrounding the City of Cleveland, Ohio, the Cleveland Water Supply System has been extended to cover all sections of the

county needing public water supply. Some of the municipalities are supplied with water on a wholesale basis; others, including the county sewer districts, construct their own distribution systems and are charged directly for the water consumed by each customer. The same arrangements have been made by the City of Chicago for the area covered by the Sanitary District. These two examples are really a combination of the method of contracting between the municipalities and of administering the service as a county function.

A notable nearby example of county organization is the recently formed Westchester County Sanitary Sewerage Commission. This fast-growing and progressive county established such a Commission for the purpose of outlining a comprehensive scheme for sewerage of the entire county and for proceeding with construction. The Commission has set up certain standards of treatment designed to eventually eliminate pollution of the beaches bordering the Hudson River and Long Island Sound.

Except for the fact that county government within the Tri-State Region is not so readily adaptable to the handling of water and sewerage projects, as in the above instances, it is to be noted that in Camden, Delaware and Mercer counties the natural topography of the land is quite suitable for such a method. Such solution, however, is generally applicable only where the saturation of population and other conditions are somewhat uniform over the entire county area. Moreover the county form of government, originally created for judicial and election purposes, was not intended to carry on extensive public works functions, and is not legislative in type and closely responsive to the electorate.

Private Enterprises.- Whenever service can be measured, private enterprises are especially feasible for covering territory made up of many municipal units. Around New York, Philadelphia and Pittsburgh, as well as other large cities of the United States, large utility enterprises serve

suburban areas made up of many independent units. An outstanding example of this type of solution lies within the Tri-State District in the recently consolidated Philadelphia-Suburban Water Company. Because of difficulties in measuring sewage flow from individual sections, private enterprise has seldom been successfully applied to the solution of sewerage and drainage problems over large areas.

Operation of Special Districts or Other Forms of Consolidation

Special, and sometimes metropolitan, districts for performing the services required in inter-community enterprises have evolved in situations where the foregoing methods are not satisfactorily applicable. The district idea, while accomplishing some of the ends obtained under a fuller municipal consolidation is distinctly different, being simpler, more flexible, and often less objectionable from the political viewpoint. It is not, however, a new type of procedure, for a number of states already have legislation permitting the formation of these special districts for the building of public works such as sewerage and water supply systems; and for flood protection, drainage of low lands and so on.

The planning and execution of inter-community functions under various schemes of consolidated management, as above, may be accomplished by three methods: (1) annexation of territory surrounding cities until natural rum limitations determine the extent, sometimes made coincident with county lines, (2) metropolitan districts to be established for particular public works or improvements as needed, (3) a modified county or enlarged city government with a central governing body but giving local autonomy in certain matters to constituent political units. These three methods of coordination generally cover the various schemes that have been tried or have been proposed throughout the country, though the details of organization and administration may differ as proposed in any particular instance.

Examples of Types Already in Operation

One of the earliest and most outstanding examples of consolidation under the first method is that of the City and County of Philadelphia in 1854. Under act of the legislature, the boundaries of the city and county were made coextensive; the new city including many small municipalities and unincorporated areas. The advantages that have accrued to these communities from being enabled to proceed with such public enterprises as a unified water and sewerage system are apparent. Hitherto disjointed and inadequate facilities were joined in unified projects. Though the County of Philadelphia was not included in the consolidation, it did not affect materially the effectiveness for the purposes mentioned.

In 1856, the City and County of San Francisco, whose boundaries had been very nearly coextensive, were combined into one corporation called "The City and County of San Francisco." This naturally eliminated the duplication of offices such as exist in Philadelphia.

A somewhat similar consolidation was initiated in Denver in 1904, and, after some legal controversy, was put into effect in 1911. The home rule powers for the new "City and County of Denver" were considerably strengthened, and the boundaries of the city were extended.

A third example is the City of Baltimore which was detached from Baltimore County in 1851 and given the status of a separate county. Since then, notably in 1918, the boundaries have been extended by annexation of territory from surrounding counties, these counties being compensated for their loss. City and County water and sewerage projects are coordinated under the Baltimore County Sanitary District operated on the "benefit district" plan.

It is probable that this method is not applicable in the Tri-State District exactly as instanced above. Recently there has been some agitation for a limited amount of municipal consolidation in Delaware County, where an entirely new municipality has been proposed. In the sections of Mercer County around Trenton there has been considerable talk of the advantages of extending the boundaries of the City of Trenton. Neither of these proposals go so far as to extend their jurisdiction to county lines.

One of the oldest and most notable examples under the second method (Metropolitan Districts) goes back to 1889, when a metropolitan sewerage system was authorized by the Massachusetts Legislature for the Boston District. This original commission has been expanded until now it is known as the Metropolitan District Commission; functioning, in addition to sewerage service, for the development and distribution of a water supply, the construction and maintenance of a metropolitan park system, a police system, and more recently for the planning of a rapid transit and highway system for the entire district.

The Boston Metropolitan District has worked out an interesting method for the division of the costs incident to the metropolitan sewerage system. The capital costs, originally met by issue of state bonds, are assessed upon the various cities and towns, using the district sewerage facilities, in proportion to their respective taxable valuations. Operation and maintenance charges, on the other hand, are in proportion to the population for the areas using the system. The cost of supplying water service is based, one-third on valuation, and two-thirds on consumption. This latter provision, of course, requires the metering of the entire supply. The members of the Board are appointed by the Governor.

The Sanitary District of Chicago provides for the development of a sewerage and disposal system for the city and more than thirty small towns, in order to protect the water supply of the large city. The District Board

is elected by the area affected, and has certain independent financial powers.

In 1916, the Essex Border Utility Commission in Canada, was authorized by the Ontario Legislature, to effect the solution of the common problems of the border municipalities. These problems included sewerage and water systems, health, parks, and planning. The Commission, consisting of 19 members, serves without remuneration and is elected as representative of the several communities.

Another early example is the Passaic Valley Sewerage Commission, organized in 1903, to construct intercepting sewers for handling the flow from communities in the northeastern portion of the State of New Jersey and lying within the Passaic drainage area. This Commission, a State organization, has contracts with 15 political sub-divisions with a population of over 1,000,000. The cost of construction was apportioned between the several municipalities according to the relative capacity required for each and the annual expense for maintenance and operation is assessed in proportion to the amount of sewage delivered by each.

It is to be noted that recently the State Legislature of Maryland has created metropolitan districts around Baltimore for certain water supply and sewerage systems.

The setting up of district commissions for such specific purposes, as outlined above, bears directly on some of the problems in the Tri-State Region. The situation in Delaware County, Camden County, and around Trenton, merits consideration of this method.

Probably the largest consolidated area in the United States is that known as the Miami Conservancy District. This district embraces all or parts of nine counties, including three large cities, covering an area of 4,200 square miles, and a population of over a million. This district was organized to carry out measures for the control of floods in the Miami River Valley after

it suffered from serious damage in 1913. Its government rests with a board of three appointed by a court consisting of a Common Pleas Judge in each of the counties affected. It is possible that this type of river conservancy organization may be particularly applicable to the communities in the Schuylkill Valley above Philadelphia, where the inter-related problems of water supply and stream pollution would profit by a unified and agreed upon program.

Legislation of a more comprehensive nature has been considered in Missouri and an Act was introduced in the Assembly of 1929, providing for the formation of river districts. These districts were defined by the natural watersheds of the major intra-state stream, of which there are approximately twenty-five in the State of Missouri. The legislation provided for one representative from each county in the watershed, with suitable appeal to the Circuit Court and approval of the Circuit Court, as well as the voters in regard to major improvements. This Act would have conferred upon the District Government comprehensive powers in regard to rivers involving stream flow regulations and river development pertaining to floods, irrigation, parks and recreation, fish culture, water supply, navigation, sanitation, public health, etc. It is proposed to re-introduce the Act for passage at the 1931 Legislative Session.

The consolidation in 1898 of the present City of New York by the formation of five boroughs is the most outstanding example of the third method (Enlarged City Government). Under this system, local autonomy is preserved for each borough, while they have the advantage of the centralized governing body formed of elected officials from each.

Of particular interest to citizens in the Tri-State Region should be the proposed charter for the Federated City of Pittsburgh. This plan, already approved by the State of Pennsylvania, but yet to be approved by the voters of Allegheny County, provides for the setting up of a municipal corporation whose

boundaries shall be coextensive with Allegheny County. This charter makes provision for the continuance of local autonomy where this does not conflict with the general interests of a larger area. It grants, however, especially broad powers for the solution of water and sanitation problems in the many un-united units of which the new city would be composed. These provisions, among other things, allow for the creation of special districts irrespective of political boundaries for which unified sewerage or water service would be advantageous, the cost for such work to be levied by a special tax throughout such districts. Existing services by either municipal or private interests are carefully protected in the proposed legislation.

The newly appointed and now operative "Regional Planning Commission of New Castle County" is endowed with exceptionally broad powers for planning and coordinating inter-community efforts. Besides having as its purpose the general duty to promote health, safety, prosperity and the general welfare, it is specifically charged to secure coordinated plans for the usual community functions, among which are water supplies, sewers, and sewage disposal. Its jurisdiction does not extend within the corporate limits of cities or towns, but it is authorized to prepare a Master Plan for approval of the Levy Court which shall then become the official recorded plan for guidance of the Commission and the Court in approval of future projects.

The Modern Viewpoint

The growth of metropolitan areas in the last decade or two has resulted in considerable agitation for further district and metropolitan consolidation. There have been proposed a variety of plans similar to the foregoing for such well-known centers as Boston, Los Angeles, Detroit, and for such suburban counties as Essex and Hudson counties in New Jersey, Nassau and Westchester counties in New York, and Alameda County in California. The most important of these, together with existing plans, are described in a

book recently published under the auspices of the National Municipal League, entitled "The Government of Metropolitan Areas in the United States".

The Metropolitan Committee of the Detroit Board of Commerce has prepared a report for a scheme that would come under the third method of consolidation mentioned hereinbefore. It states, "This proposal has been advanced with one principal thought - to secure a governmental area or areas large enough to undertake certain projects that cannot be undertaken satisfactorily by the cities and villages individually. The government of such a metropolitan district or districts would be distinct from the government of the cities or villages included and the area would be sufficiently large to permit the orderly development of water supply, rapid transit, sewerage, port facilities and also possibly to deal with health, education and police."

Of special importance to the Philadelphia Tri-State District is an act now under consideration by the legislature of the State of New Jersey. It is proposed to divide the entire State into four regions, formed from groups of counties, and each of which would be governed by a District Commission composed of a member elected from each county in the region. Among some of its powers it would "undertake a continuous study of the needs of the district in whole or part as they relate to public works, services and utilities; to study and favor public hearings * * * * * adopt a regional plan for the coordinated development of the district as a whole, and study the possibilities and advantages of coordinating or consolidating existing and new public works, services and utilities, whether publicly or privately owned and/or operated." Further powers enable each of these commissions "to construct, purchase, or otherwise acquire and maintain and operate any public works or utilities affecting more than a single municipality or county." The Commission would also have the power of allocating the cost of such work. One of the outstanding provisions of the proposed act is for the appointment, at the discretion of the

Commission, of an executive officer, equivalent to a Regional District Manager, to supervise and coordinate the works of the district and generally act as executive and adviser to the Commission.

This Commission would apparently not interfere with such regional activities as are now being carried on by the State Highway Commission, Port authorities, and the various County Park Commissions. It specifically would not interfere with the control of established utilities or works now owned by the municipalities, excepting with their consent, and would serve in a more effective way to solve the very problems for which annexation has been proposed as the only remedy. One of the four districts proposed by this act almost exactly coincides with the New Jersey part of the Tri-State Region.

It must be remembered, however, that there are pitfalls to be avoided in Metropolitan or other Special Districts. The difficulty of securing complete representation, sometimes leads to opposition on the grounds of 'Taxation without Representation'. The development of works ahead of immediate needs, is apt to be criticized; but with wise forethought and comprehensive planning, only a few permanent units need to be built for future conditions, the greater part of the construction may be carried out from time to time as required. The distribution and apportionment of costs, and the determination of what part, if any, shall be borne by territory not yet developed, but which will be brought into development and use by the building of such works, are all difficult; these have proved to be the rocks upon which many a good scheme has been wrecked. Such dangers, however, are not inherent in the method, and all of them may be avoided, if local pride and self-interest be eliminated, and if a broad public-spirited view be taken by all the interested communities and representatives.

GENERAL CONCLUSIONS

It is evident from the variety of the foregoing types of coordination that the best method in any particular instance will depend entirely upon the local conditions, the financial situation of the units, their political relationships and individual needs, as well as the legally possible alternatives, which vary considerably in each State. No criterion can be formulated as to the best method in any case. It is evident that unbiased public discussion of the various alternatives is absolutely a prerequisite to the best choice.

One of the strongest arguments for a broad and cooperative attack of water and sewerage problems is that it furthers the growth of regional consciousness in the public mind. By sharing responsibilities in the common problems of extensive areas, communities will learn to work together while, at the same time, preserving their own integrity. Furthermore, it should strengthen the power and better direct the efforts of a strong State supervisory department, by giving it larger and better organized units with which to deal.

In the chapter of the main regional plan report devoted to Water Supply and Sanitation, there have been summarized the specific recommendations and conclusions of the committee. They represent the outstanding points at issue herein, brought out in the analysis of this problem and constitute matters of principle commended to the communities of the region for their consideration.

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